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THE OPERATIONS OF SURGERY



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THE
OPERATIONS OF SURGERY

INTENDED ESPECIALLY FOR THE USE OF
THOSE RECENTLY APPOINTED
ON A HOSPITAL STAFF

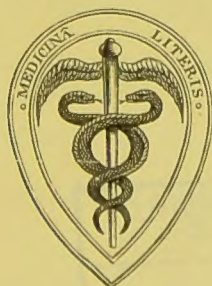
AND FOR
THOSE PREPARING FOR THE HIGHER EXAMINATIONS

BY
W. H. A. JACOBSON

M.CH. OXON., F.R.C.S.
ASSISTANT-SURGEON GUY'S HOSPITAL; SURGEON TO THE ROYAL
HOSPITAL FOR CHILDREN AND WOMEN

THIRD EDITION

WITH THREE HUNDRED AND NINETY-EIGHT ILLUSTRATIONS



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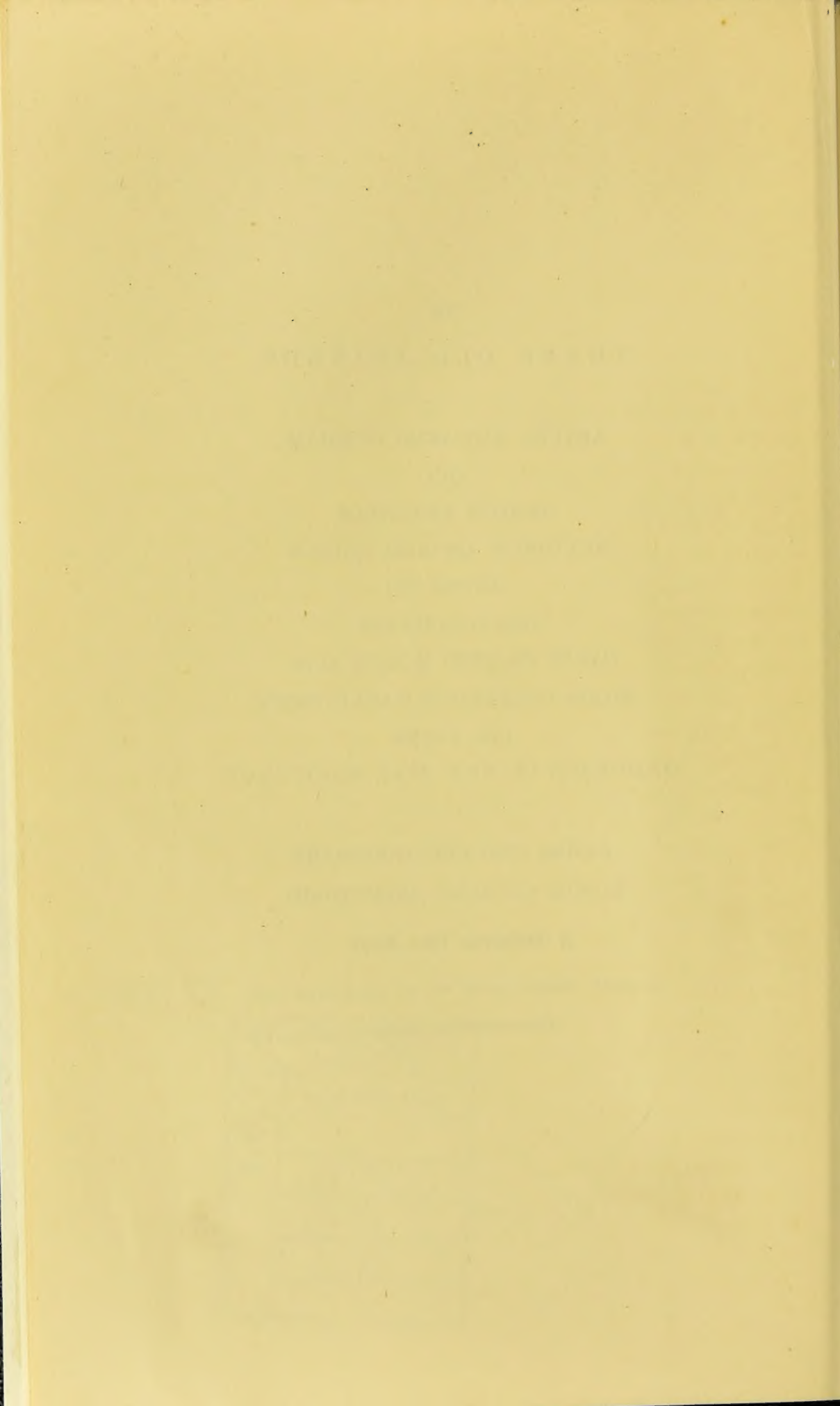
TO
THREE OLD FRIENDS

ARTURO EDUARDO DURHAM
QUI
OMNIUM AMICITIAM
MULTORUM AMOREM UNICUM
ANNOS LXI
SIBI CONCILIANS
CARUS PRÆTER MODUM SUIS
ÆGRIS PAUPERIBUS PARVULISQUE
PRO PATRE
OBDORMIVIT NON. MAI. MDCCCXCV

JAMES FREDERIC GOODHART
EDWIN CLIMSON GREENWOOD

I Dedicate this Book

AS SOME SLIGHT TOKEN OF MY GRATITUDE AND
AFFECTIONATE RESPECT



PREFACE TO THE THIRD EDITION.

THIS book, of which the first edition appeared in 1888 and the second in 1891, was the outcome of a strong belief, which I have held for many years, that a work on Operative Surgery which aimed at being more comprehensive in scope and fuller in detail than those already published, would be of service to many who had recently been elected to hospital appointments, and to those who were working for the higher examinations. For the delay connected with the appearance of the present edition, I, alone, am responsible. It has arisen partly from other calls on my time, but chiefly from the time and trouble which are needed in an attempt to bring a book like this up to date, and from the dissatisfaction which increases, with increasing experience, at each result.

I would take this opportunity of expressing my gratitude both to the publishers, Messrs. Churchill, and the printers, Messrs. Ballantyne, Hanson & Co., for the forbearance which has been so patiently shown to me.

Of the 199 illustrations in the first edition the majority were made by Dr. C. W. Hogarth. For most of the 199 which have since been added I am indebted, through M. Masson the publisher, to Prof. Farabeuf's *Précis de Manuel Opératoire*, and, through Herren Lipsius and Tischer of Kiel, to Prof. Esmarch's and Dr. Kowalzig's *Chirurgische Technik*. My knowledge of the latter book is entirely owing to Mr. Lockwood. I should also acknowledge here my indebtedness to Sir W. MacCormac, Mr. Anderson, Mr. Jessett, and Mr. F. T. Paul for their permission to make use of blocks and illustrations.

Dr. Dakin, obstetric physician to St. George's, has relieved me of the task of bringing up to date the chapter on "Operations on the Uterus," and also the section referring to "Removal of the Uterine Appendages."

Believing that a single volume with a very full index is the

most helpful form of reference to busy readers, I have, as yet, resisted the temptation to expand the book into two volumes. To admit all that has been added to this edition, and, at the same time, to keep the book within the compass of a single volume, I have made use of small print, more especially in the latter half of the book, when describing cases and in the accounts of the less frequently employed operations, and also of a deeper page.

I am well aware that much of the book will require re-writing. This is unavoidable in a subject so progressive and changeful as Modern Surgery; it is especially unavoidable when a writer desires to do full justice to the work done by the crowd of labourers engaged in the same field at the present time. Many of the methods suggested in these pages will, later on, be rejected, but it is only by submitting novelties and suggestions to the one true test, that of Time, that we shall know how many are really worthy to survive. If my book aids in bringing about the application of this test, it will not have failed, altogether, in its purpose.

The sections on "Antiseptic Surgery" and on "Anæsthetics" have been omitted. They have been completely superseded by Mr. Lockwood's *Aseptic Surgery*, and Dr. Hewitt's *Anæsthetics and their Administration*; two books which should be in the hands of every senior student.

The plan of the book, with which some of my judges found fault, remains unchanged. I adopted the division by Regions deliberately, desiring that those for whom the book is intended should study the anatomy of each region at the same time as the account of the operations.

It remains for me to acknowledge, very gratefully, the encouragement given me by my reviewers and a host of correspondents from all parts of the world. I only wish that my book deserved better the kind things that very many have written of it.

W. H. A. JACOBSON.

66 GREAT CUMBERLAND PLACE,
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January 1897.

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PART I.

OPERATIONS ON THE UPPER EXTREMITY.

CHAPTER I.

OPERATIONS ON THE HAND.

AMPUTATION OF FINGERS.

Practical Anatomical Points.—I. POSITION OF JOINTS (Fig. 1).
—This has to be remembered—(a) in front, (β) behind.

(a) *In front.*—Three sets of creases correspond here, though not exactly to the joints. Of these, the lowest crease is just above the joint; the middle is opposite to the inter-phalangeal joint; the highest, nearly $\frac{3}{4}$ inch below the metacarpo-phalangeal joint.

FIG. 1.



(Farabeuf.)

(β) *Behind.*—It is to be remembered here (1) that in each case it is the upper bone which forms the prominence—viz., the knuckle is formed by the head of the metacarpal bone, the inter-phalangeal prominence by the head of the first phalanx, and the distal one by the head of the second; (2) that the joint in each case lies below the prominence, the distal joint being $\frac{1}{2}$ inch, the

inter-phalangeal $\frac{1}{6}$ inch, and the metacarpo-phalangeal joint about $\frac{1}{3}$ inch below.*

II. SHAPE OF JOINTS.—In the distal and the inter-phalangeal the joint is concave from side to side, and presents a concavity towards the tips: in the metacarpo-phalangeal joint, on the other hand, the convexity is towards the finger-tips.

III. THE THECA.—This fibrous tunnel running down to the bases of the distal phalanges and upwards to the palm gapes widely after section. From the readiness with which the tendons conduct sepsis into the forearm itself, care should be taken to keep even such a small amputation as that of a finger strictly sweet, and, in amputating through damaged parts, the flaps should not be too closely united with sutures.

Owing to the frequency with which suppuration follows crushes of the fingers and the serious trouble which this may cause in the palm, Mr. Treves (*Oper. Surg.*, vol. i. p. 322) advises that the theca be closed with fine catgut sutures. This, he remarks, will be found easy where the sheath crosses the joints, but opposite to the bones there is much difficulty, since the sheath is united to the periosteum and that membrane very thin. The periosteum should therefore be here stripped up a little from the palmar aspect of the bone before this is divided.

Operations for Amputation of the Fingers.—As one fixed method is rarely available, and as the rule here to remove as little as possible is unalterable, several should be practised, included among them the following four, of which the first two are the best—viz.:

1. Long palmar flap (Figs. 2, 4, and 5).
2. Long palmar and short dorsal flap (Fig. 6).
3. Two lateral flaps (Fig. 6).
4. One long lateral flap.
5. Two equal antero-posterior flaps.†

Of these, the palmar flap is usually the one made use of. Though, as the hands are by far most frequently placed in the prone position, a dorsal flap falls more easily into place, and gives a more concealed scar, a palmar flap has the greater advantages of a scar which is not pressed upon when anything is held in the hand, of possessing finer sensitiveness in touch and better nutrition; furthermore, this flap is available even in the last phalanx, where, from the presence of the nail, a dorsal flap is not obtainable (Fig. 2).

Amputation of the Distal Phalanx by a Palmar Flap (Fig. 2).—First Method.—The hand being pronated, a strip of lint wound round the phalanx to give a firm grip,‡ and the adjacent fingers well flexed, the surgeon, having placed his left

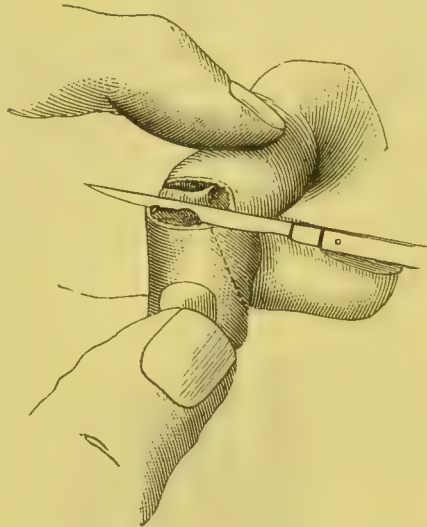
* The terms "above" and "below" mean nearer and farther from the trunk.

† These will produce a stump with an exposed scar.

‡ In the drawing this is left out for the sake of distinctness.

fore-finger just below and behind the joint, and flexed the phalanx strongly with his thumb (a step not always easy with infiltrated tissues), cuts,* with a slightly semilunar sweep, straight into the joint. To effect this neatly, the convexity of the sweep should pass $\frac{1}{2}$ inch below the prominence or angle produced by flexion, the sweep being made by laying on the whole edge of the knife, while with the point, as this incision begins and ends, the lateral ligaments are partly cut. The joint being thus freely opened, the knife is insinuated behind the base of the phalanx (a step which is facilitated by depressing and pulling on the phalanx), and then, being kept close to, and parallel with, the bone, cuts with a steady sawing movement, a flap well rounded at its extremity, about two-thirds in length of the pulp of the finger.†

FIG. 2.†



Second Method.—The hand being supinated, the finger to be operated on extended, and the others flexed out of the way, a palmar flap is cut by transfixion, the knife being entered just below the palmar crease, the joint being then opened from the dorsum as before, and the phalanx lastly disarticulated. If transfixion be made use of, the following comment of Mr. Treves (*loc. supra cit.*, p. 327), must be remembered: “In no operation upon the fingers is it well to cut the flaps by transfixion. In cutting a palmar flap by this means there is danger of slitting up the digital arteries. The flap, moreover, is apt to be pointed and scanty, and to contain fragments of tendon.”

Third Method.—If the surgeon has no narrow knife by him, he may modify the last method by cutting his palmar flap first, but from without inwards; he then opens the joint from the dorsum, and disarticulates.

As a rule, no vessels require ligature. Any tendon that is jagged should be cut square.

Difficulties and Mistakes in Amputation of Distal Phalanx.—(1) The flap may, of course, be made too short; it is often made too pointed. I would take this opportunity of reminding my younger readers that as the long bones of the hand are large in

* The knife in all these finger amputations should be narrow, short, and slender yet strong.

† The palmar flap here is made somewhat too short, sharp, and wedge-shaped.

‡ If the flap is insufficient, the head of the second phalanx must be removed. In this and in other amputations in the hand, owing to the soft parts cut through being often infiltrated and fixed, the flaps are easily made too short, from the desire of the surgeon to leave as much as possible.

relation to their soft parts, the flap or flaps should always be cut sufficiently long. The student must in this, his first amputation, fix upon his mind a rule which must be followed in all amputations, large and small—to measure with the eye whether the flap or flaps will be sufficient, just before the flap is finally cut.

(2) If the phalanx be not sufficiently flexed, or if the site of the joint has not first been marked out with the nail, the latter will not be readily opened. It is very common for students, forgetting that in the case of each joint this lies below the corresponding prominence (Fig. 1), to cut above the level of the joint here, their knife sawing against the neck or head of the second phalanx.

(3) It is often difficult to pass the knife readily behind the base of the phalanx, especially in cases where the blade is too broad,

or where, as in well-developed hands, the base of the phalanx is strongly tuberculated. (4) If there be any hitch in passing the knife behind the phalanx, the outline of the flap is very likely to be jagged, and to cause sloughing.

FIG. 3.



Different methods for partial removal of the fingers. In the index two rounded lateral flaps; in the middle finger two square dorsal and palmar; in the case of the ring finger two rounded flaps, dorsal and palmar; and in the little finger a single dorsal flap are shown. (Farabeuf.)

Amputation of the Second Phalanx.—This, as a rule, should be performed through the phalanx, and, wherever this is possible, beyond its centre, so as to leave the upper half or third of the phalanx, and thus ensure some attachment of the flexor being preserved.

While the rule not to amputate a finger at the joint between the first and second phalanges, and *a fortiori* through the first phalanx, is a sound one, as there is a risk of leaving a stump stiff and incapable of flexion, there is no doubt whatever that at times the above amputation has been followed by the flexor tendon taking on a fresh and sufficiently firm adhesion, and so leaving a longer and, withal, a mobile stump.

In the following special cases the whole or part of the first phalanx may be left, and in all of them the severed flexor tendons should be carefully stitched with carbolised silk to the cut theca and periosteum, or into the flaps before these are adjusted.

(1) In the case of the index finger the proximal phalanx will be a useful opponent to the thumb, as in holding a pen. (2) In the case of the little finger, leaving the proximal phalanx will give greater symmetry to the hand when this is flexed, and it should accordingly be left, if the patient desire it (Fig. 10). (3) In amputation of all the fingers, the proximal phalanx of one should, if pos-

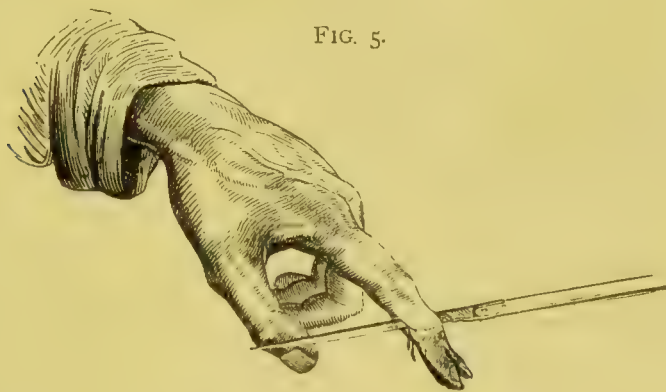
sible, always be left to oppose to the thumb. (4) Where a patient insists on having the proximal phalanx left, after the risk of stiffness has been explained to him. The more care is taken to fix the severed flexors to the theca, the more quickly the stump heals, and the younger the patient, the greater will be the movement gained.*

FIG. 4.



Amputation through the inter-phalangeal joint by a long palmar flap, the joint being opened first. (Fergusson.)

FIG. 5.



Amputation through the second phalanx by a long palmar flap, this being made first by transfixion. (Fergusson.)

Amputation through, or Disarticulation of the Middle Phalanx.

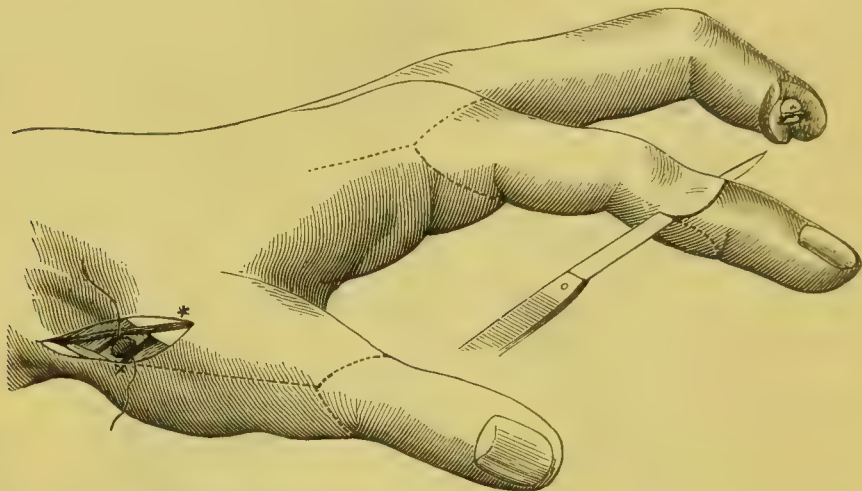
(1) By a Long Palmar or Dorsal Flap (Figs. 3, 4 and 5), or by

* Dr. Tiffany, of Baltimore (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 826), says that he has been in the habit "for a number of years" of passing the stitches which unite the skin through the tendons and their sheaths in amputation at the joint between the first and second phalanges. "I have never failed, as far as I can remember, to secure quite as good movement as if Nature had originally made an attachment there for these tendons."

Dorso-palmar Flaps, the flaps being equal, or the palmar one the longer (Figs. 3 and 6).

By Dorso-palmar Flaps.—The surgeon, marking with his left fore-finger and thumb * where he intends to divide the bone, cuts between these points a short, well-rounded dorsal flap of skin; he then sends his knife across below the bone, making it enter and

FIG. 6.



In the second finger, amputation through the second phalanx by lateral flaps is shown. The bone has been divided below the insertion of the flexor sublimis; if there were any doubt about this, the tendon would be stitched to the theca and flaps, as advised at p. 4. In the index finger, amputation through the second phalanx by short dorsal and long palmar flaps is figured. The left finger and thumb of the surgeon, which would mark the base of the flaps, are left out for the sake of distinctness. The flaps for amputation of the index finger at the metacarpo-phalangeal joint are also shown, the straight part of the incision being placed rather to the radial side of the head of the metacarpal bone. The scar would be better hidden if the incision had been placed on the ulnar side (p. 8).

In the thumb, the flaps for amputation at the carpo-metacarpal joint are indicated. The two * * show where the radial artery may be wounded, near the joint, and in the interosseous space, in this amputation (p. 11).

Ligature of the radial artery at the back of the wrist is also represented. The radial vein crosses the wound from angle to angle. The artery, with the ligature under it, is shown between the extensor ossis metacarpi and extensor primi internodii in the lower angle, and the extensor secundi internodii in the upper angle of the wound (p. 49).

emerge at the base of the first flap, and cuts a palmar flap about $\frac{2}{3}$ of an inch in length, and not pointed. The flaps are then retracted, the bone cleared with a circular sweep of the knife, and divided in the manner given below.

By Lateral Flaps (Fig. 6).—The site where the bone is to be sawn being marked by the left forefinger and thumb placed on the dorsal and palmar aspects of the finger at this level, the surgeon, looking over the finger, enters his knife in the centre of the palmar

* These are left out in the drawings for the sake of distinctness.

aspect, and carries it, cutting an oval flap, about $\frac{1}{2}$ inch in length, to a corresponding point on the centre of the dorsum, and then from this point down again over the side of the finger nearest to him, to the point where the knife was first entered. The flaps being dissected up as thick as possible, and the remaining soft parts severed with a circular sweep, the bone is divided with saw or bone-forceps. If necessary, one flap can be cut longer than the other. In using the bone-forceps the concave surface is always to be turned away from the trunk; if this precaution is taken, and the bones severed quickly, the section will be clean, and not crushed. But a fine metacarpal or a small Butcher's saw is the safer instrument.

Amputation of Finger, e.g., Second or Third, at the Metacarpophalangeal Joint (Fig. 7 and 8).—This, the most frequently performed amputation on the hand, should be often practised. It is usually performed by the modified oval method, the *en raquette* of Malgaigne. Lateral flaps I consider better. Other methods, to be used according to the condition of the soft parts, are shown (Fig. 8).

The hand being pronated, the radial and ulnar arteries commanded by an Esmarch's bandage above the wrist, some lint wrapped round the damaged finger, and the adjacent ones flexed out of the way, the point of the knife is entered $\frac{3}{4}$ inch above the head of the metacarpal bone, sunk down to the bone itself, and then carried down in the middle line till it gets well on to the base of the phalanx; then, diverging to one side, the knife is carried obliquely below the web* across the palmar aspect of the first phalanx below the palm, and then around the other side of the phalanx (also below the web) so as to join the straight part of the incision which lies over the head of the metacarpal bone.

Lateral Flaps.—In practice, especially in the country, where an anæsthetic is not always easily available, it is much preferable, because quicker, to make two separate incisions, each beginning $\frac{3}{4}$ inch above the head of the metacarpal bone, and meeting again on the centre of the base of the palmar aspect of the first phalanx, well below the palm, instead of carrying the knife continuously round the finger. This method is not only quicker,† but it does

FIG. 7.



Incisions for amputation at the metacarpophalangeal joint. If the metacarpal bone requires removal as well, the apex of the incision would be prolonged upwards. (Fergusson.)

* Cutting into the web will lead to much more hæmorrhage, too short flaps unless the head of the bone is removed, and increase of pain in healing.

† Because it avoids the hitch usually met with in carrying the knife around the base of one finger between others.

not leave, as in the first method, a small tongue of tissue on the palmar aspect, which is a little difficult to adjust satisfactorily, and behind which discharges may collect.

In either case the knife should be used boldly, the extensor tendon severed in the first incision over the head of the metacarpal bone, and the soft parts at the sides cut to the bone. Then one lip of cut tissue being taken up with the finger and thumb, the flaps are dissected up as thick as possible, tendons cut clean and square, the lateral ligaments severed, and the joint opened by remembering its site well below the projecting knuckle (p. 1, Fig. 1). Disarticulation will be facilitated by twisting the finger, first to one side, and then to the other, so as to render tight the parts which remain to be cut.

Where strength has to be considered rather than appearance, the head of the metacarpal bone should be left, whatever be the rank in life of the patient, as the transverse ligament is thus less interfered with, the hand less weakened, and the palm not opened up. But where appearance is the most important thing, and the mutilation is to be hidden as much as possible by the approximation of the fingers, the head of the bone should be removed by a narrow-bladed saw or by bone-forceps.* In either case the section should be made obliquely from above downwards and from behind forwards, so as to remove more on the dorsal than the palmar aspect. In such cases, after a little practice, it is not necessary to perform disarticulation, the metacarpal bone being severed after dissecting up the flaps to the proper level. Here, too, care must be scrupulously taken not to interfere with the tissues in the palm.

After removal of the finger and the Esmarch's bandage, one or more digital vessels will require ligature, lying rather deeply opposite the web of the finger.†

In the case of the index (Figs. 6 and 8) or little finger, the straight part of the oval incision should be placed to the ulnar side of each metacarpal bone, rather than in the dorsal mid-line, as, in the former case, the line of incision will be better concealed between the thumb and second finger, and in the latter, be less visible in the ordinary pronated position of the hand. In these cases the saw or bone-forceps should be applied obliquely from without inwards and from within outwards respectively, so as to leave no projecting bone on the radial or ulnar aspect of the hand, and, in the former case, to allow of the thumb being readily approximated to the adjacent finger.

It may be worth while to add one hint with regard to the after-treatment, and that is, not to bandage the adjacent fingers too

* With the precautions already given at p. 7.

† Care should be taken to secure these vessels, especially where they are enlarged in any inflammatory condition, otherwise profuse bleeding may take place a few hours after the operation.

closely or too long together, otherwise a tendency to cross at their points will be noticed later on.

Disarticulation by a Circular Incision with a Straight One on the Dorsum (Fig. 8).—This method, a modification of the one *en raquette*, is preferred by Farabeuf as simpler and sacrificing less skin. The hand being completely supinated, and the other fingers bent out of the way, the surgeon cuts across the root of the finger in the digito-palmar fold, going down to the bone, and encroaching as far as possible on the sides of the finger.

FIG. 8.



Different methods of amputating the thumb and fingers at their metacarpophalangeal joints. In the case of the thumb a long palmar flap has been made; in the index a palmar and external flap; in the middle finger a circular incision with a straight dorsal cut (a modification of the method *en raquette*) have been employed; the ring finger has been removed by two lateral flaps, and the little one by an internal and palmar flap. (Farabeuf.)

The hand being pronated, the ends of the circular incision are prolonged up to the middle line of the dorsal aspect of the finger, where a straight cut, beginning a little above the level of the joint, is drawn down to and perpendicular to the first. By this means, two right-angled flaps are marked out. These are raised, and the bone disarticulated, by the steps already given.

Amputation by a Single Flap.—Where, owing to the state of the soft parts, this method is required, Fig. 8 shows how it may be employed.

Amputation of a Finger, together with Removal (complete or partial) of its Metacarpal Bone.—This

operation is easily performed by a modification of the method *en raquette* or that by lateral flaps just described. It is only needful to prolong the dorsal part of the former incision or the apex of the latter as far as the carpo-metacarpal joint. Disarticulation, when the parts are much swollen, will be safely performed here by carefully prolonging back the dorsal incision in a wound kept bloodless till the joint is felt and seen, suitably manipulating the finger so as to put the structures attached to the metacarpal bone on the stretch, remembering the insertion of tendons into some of these bones, and not sinking the knife into the palm for fear of wounding the palmar synovial sac or the deep palmar arch.

In the case of the little finger the ulnar border should be chosen for the incision, or if the dorsal tissues are much damaged a palmar and internal flap may be made. In clearing the metacarpal bone the knife point must be kept very close to the bone. If only a portion of the bone needs removal, this should be divided with a saw and not bone-forceps. Farabeuf gives the very practical hint that primary union should be secured by the flaps meeting readily. Otherwise the contraction of the scar will drag upon the next surviving finger, and cause it to stick out from its fellows in a very ugly fashion.

Amputation of Two or Three Contiguous Fingers.—

When (a very rare contingency) two or more fingers require removal at the same level—*i.e.*, through their metacarpo-phalangeal joints, or higher up, the modified racquet or lateral flaps may again be employed, the apex of the dorsal incision starting between the fingers when two, and over the central metacarpal bone when three, fingers have to be removed.

AMPUTATION OF THUMB.

Amputation of Phalanges of Thumb.—Very little need be said about these, as they are very rarely performed. Owing to its numerous muscles, the thumb is extremely mobile, and thus escapes injury. Thanks to its abundant vascular supply, trimming of the soft parts after an injury will generally leave more of the thumb to oppose to the fingers than any set operation.

In cases of necrosis after whitlow, I have twice removed both phalanges, the soft parts consolidating usefully* with the aid of the periosteum that is left. For further remarks on preserving the thumb, see Excision of Thumb, p. 12.

Operation.—Amputation of the phalanges of the thumb may be performed, in the case of the distal one, by a long palmar flap, as in the case of a finger (Figs. 4, 5, 6); in the case of the first phalanx, by antero-posterior, lateral, or a modification of the oval

* This is strongly indicated in those cases where it is especially important to leave the thumb long for holding a pen or delicate instrument.

method. In any case the incisions should be carried well on to the phalanx to ensure sufficient flaps to cover the head of the metacarpal bone, together with the sesamoid bones, which should never be removed.

The line of the metacarpo-phalangeal joint is very nearly transverse, and lies just in front of the knuckle.

After amputation of either phalanx, the severed end of the long flexor should be carefully stitched into the angle of the flaps and to the theca and periosteum.

Amputation of the Thumb at the Carpo-metacarpal Joint (Figs. 6 and 9).

Indications.—This operation is rarely called for on the living subject.* Gunshot injuries, enchondromata of phalanges and metacarpal bone (see below, p. 12), epithelioma of a scar, and melanotic sarcoma, occasionally call for it.

Operation.—The position of the joint between the trapezium and metacarpal bone, its shape, with two saddle-like articular surfaces fitting into each other “by reciprocal reception,” and the position of the radial artery passing over the back of the styloid process just above this joint (Fig. 6), and again, when perforating, the first interosseous space, lying close to the metacarpal bone, must be remembered.

The operation is usually performed by the oval method.

An Esmarch's bandage being applied above the wrist, the hand held midway between pronation and supination, and the thumb held rather over-extended so as to relax the parts, the surgeon enters the point of a strong narrow scalpel or bistoury just above the joint. This lies a full finger's-breadth below the tip of the styloid process. Its position can usually be made out by tracing up the metacarpal bone with one finger along its inner, and the thumb along its outer, margin, the thumb being abducted and adducted. The knife, entering between the tendons of the extensor ossis and brevis pollicis, should avoid *la tabatière anatomique* (p. 49) and the radial artery. Where there is much swelling comparison must be made with the sound thumb. The incision is then carried along the dorsum of the bone as far as the base of the first phalanx, where it passes (in the case of the left thumb) obliquely to the ulnar side above the web, and then around the palmar aspect of the phalanx, along the radial side, to join the dorsal incision again. Taking up first one edge of the incision and then the other, the surgeon dissects up the soft parts from the bone, keeping the knife-point very close to this, especially on the inner side. The extensor tendons and the short muscles of the thumb being severed, the joint between the trapezium and metacarpal bone is felt for and opened, and the thumb removed, by putting the remaining tissues on the stretch by twisting the metacarpal bone in different directions.

* It is not unfrequently used as an examination test.

Amputation of the Thumb at the Carpo-metacarpal Joint by Transfixion (Fig. 9).—The hand being held as before, and the parts relaxed by slightly adducting the thumb, an incision is made (in the case of the left thumb) from the base of the metacarpal

FIG. 9.



bone rather to its palmar aspect, along its dorsum, and then obliquely to the ulnar side of the base of the first phalanx; the knife, a long narrow bistoury, is then pushed from this point at the junction of the web with the thumb, across the palmar aspect of the thumb, to the point where the incision started, over the carpo-metacarpal joint. By cutting outwards, along the line indicated in Fig. 9, a flap is formed of the tissues in the ball of the thumb, the knife being kept close to the bone at first, but used more lightly and kept more superficial afterwards, as it comes out through the skin over the sesamoid bones and base of the first phalanx, to avoid being locked here. This flap being held back, the metacarpal bone is dissected out by keeping the knife close to it, the joint opened, and the thumb removed as before.

On the right side, it is better to cut the palmar flap by transfixion first, making it enter and emerge just as above given. The blade of the knife is then drawn from the base of the first phalanx obliquely across the dorsum of the metacarpal bone, from one extremity of the transfixion incision to

the other. The operation is then completed as before.

In practice, total removal of the thumb is one of the rarest amputations. Part of the metacarpal bone should always be left, if possible. Even if stiff, it will be most useful when the fingers are opposed to it.

EXCISION OF THUMB.

Removal of Phalanges.—Owing to the exceeding value of the thumb, a phalanx should always be preserved if possible, not only in whitlow-necrosis, but in the case of the first or proximal phalanx, when it is the seat of enchondroma. By this, not only is appearance saved by the lessened shortening, but the use of the long flexor, in particular, is preserved.

Mr. Royes Bell (*Lancet*, 1872, vol. ii. p. 846) published a case in which he excised the proximal phalanx in a woman, aged nineteen, for a huge enchondroma of sixteen years' growth, the joints being movable. The phalanx was excised by two semi-lunar incisions over the tumour, the knife kept close to the

bone, and the joints opened. No tendons were cut. Eighteen months later the condition of the thumb was excellent, both for all general movements and for writing.

Removal of Metacarpal Bone.—This should always be excised wherever possible, in preference to sacrificing a part of such incalculable value as the thumb.

Sir W. Fergusson (*Pract. Surg.*, p. 322), in speaking of this operation, says that he saw it once performed, and, though the organ was far from strong, the patient could use a needle with tolerable facility not long after, and he further remarks that the comparative shortness of the bone removed, and the firm cushion of soft parts that remains after its excision, will make the remaining part useful.

A straight incision, which reaches $\frac{1}{4}$ inch beyond each extremity of the bone, having been made along the dorsum, the tendons are drawn aside; the distal end and joint are next cleared and opened, when the bone can be used as a lever whilst it is freed from the soft parts on the palmar aspect and then disarticulated. If possible, the periosteum should be preserved.

The radial artery must be remembered both on the ulnar side of the metacarpal bone and by the carpo-metacarpal joint (Fig. 6).

Excision of Metacarpo-phalangeal Joint.—This may be very occasionally required in those cases where a dislocation of the first phalanx cannot be reduced, either as a primary operation or, later on, in a young and healthy patient, to whom the stiffness is a serious drawback. Still rarer cases are where the dislocation can be reduced but recurs at once.

An incision, $1\frac{1}{2}$ inch long, on the ulnar side will leave least scar. When the joint is opened, any tight bands, whether of ligament or the flexor brevis, are divided.* If more is required the soft parts are freely retracted, and the base and upper end of the displaced bone having been cleared by keeping the knife-point closely applied to it, sufficient of the phalanx is then removed *in situ* by a narrow saw, which is preferable to bone-forceps. Free resection of one bone will probably suffice, if sufficiently free, but if, owing to the amount of matting, or previous inflammation, there be additional risk of ankylosis, the head of the metacarpal should be removed as well. Care must be taken, before the base of the displaced phalanx is removed, to detach carefully with a suitable blunt dissector the tendons inserted into it. Passive movements should be begun a few days after, and persevered with until the cure is complete.

EXCISION OF FINGERS.

Only excision of joints need be alluded to here as, save in the case of removal of the distal phalanx (or the last two in the case

* In a case of Mr. Turner's (*Clin. Soc. Trans.*, vol. xxi. p. 170) it was a very tense long flexor, which had slipped to the inner side of the metacarpal bone, and thus prevented reduction until pulled up with a blunt hook.

of the index) for necrosis, excision of a phalanx leaves a very useless finger.

Excision of an Inter-phalangeal or Metacarpophalangeal Joint.—This may be called for after a clean cut into the joint (circular saw, &c.); in the hope of saving one or more damaged fingers when several have required amputation after a machinery accident; in some cases of compound dislocation; in a few cases of disease—thus, in young subjects in the case of the index finger, *e.g.*, where there is only one joint affected, and the mischief is limited to the articular surfaces and the bones themselves are sound. Excision of one of the above joints is best performed by an incision, $1\frac{1}{2}$ inch long, to one side of the dorsum of the joint. By a sufficiently free dorsal incision the extensor tendon can be readily separated from the bones beneath. In the case of recent dislocation the surgeon, when the joint is opened, should examine into the cause of the irreducibility. Thus, in the case of the metacarpophalangeal joint this may be the glenoid ligament detached and stretching across the head of the metacarpal bone. After division of this, reduction may be at once possible. (Davies-Colley, Symonds, *Lancet*, 1888, vol. i. p. 522). If it is necessary to go farther, the lateral ligaments being severed, the joint is dislocated, and the ends of the bones removed with a narrow, clean-cutting saw, the soft parts being as carefully protected from damage as possible.* The surgeon should always remove the bone freely, and not content himself with paring off the articular surface, and thus risking the formation of a stiff joint. Drainage being provided with a strand of aseptic horsehair, the wound is partly closed, and the finger put up somewhat flexed.† Careful passive movement should be commenced about the third day, gas or ether being given if necessary.

CONSERVATIVE SURGERY OF THE HAND.

While every case must be decided by itself, I trust that the following may be of service to my younger readers when called upon, suddenly, to form what is one of the most momentary decisions in all surgery.

i. The question of trying to unite a totally separated part is alluded to at p. 17.

ii. Save in the very rarest cases, where the combined comminution of bone, injury to tendons, and stripping off of skin is extreme, no set amputation is to be performed. In the case of a part of such incalculable value, and so well supplied with blood as the hand, the surgeon should remember Verneuil's words and not "approach these cases with the bistoury." He is to render the

* If any tendons are cut, they should be united with sutures.

† On a carefully moulded felt splint, or one of perforated zinc.

parts thoroughly aseptic, and then to wait and see what Nature will do towards leaving the parts ultimately useful.

iii. But while it is a cardinal principle to preserve every inch of the hand, a single finger or a thumb alone being far more useful than the most elaborate artificial limb that can be made, and while to gain this end it is frequently advisable to trim up an injured part and to remove dead bone in preference to doing any set amputation, it must always be remembered that a part may be capable of being saved, and yet ultimately be useless, unless it be at least partially movable. Again, atrophy of a part, at first promising in usefulness, may set in some time after the injury, brought about largely by trophic disturbances. In either of these cases a rigid, cicatricially contracted claw, or a pointed, sensitive and shrunken part may call, later on, for amputation.

iv. Amongst the very exceptional cases which call for primary amputation are those where (1) one or more fingers are mangled and pulped out of all shape or recognition; (2) where all the tendons are torn through, especially if this has happened at more than one place, as in the fingers and in the palm also, and where with these injuries there is much opening of the joints as well as fracture of the bones and ripping off of the skin; (3) where the fingers are extensively split longitudinally (Fig. 5); (4) another condition, which surgeons in large manufacturing centres are certain to meet with, requires grave consideration—*i.e.*, where a hand is flayed, owing to its having been caught between rollers which hold, but do not crush; here, as the patient draws back, the skin is stripped off, like a glove, up to the wrist. If, in addition, bones are crushed, the palmar thecæ opened, amputation, leaving part of one finger, if the thumb is intact, or through the wrist-joint, should be performed at once; and Billroth (*Lect. on Surg., Pathology, and Therapeutics*, Syd. Soc. trans., vol. i. p. 207) advises this step where the skin is completely stripped off without other injury, fingers entirely deprived of their skin almost invariably becoming gangrenous, and the result being, “under the most favourable circumstances, nothing more than an unwieldy cicatrised stump.”

The following case (Dr. Gregory, of St. Louis, U.S., *Amer. Surg. Assoc.*, vol. ii. p. 232) is a good instance of the truth of the above:

The hand of a little boy was caught in the rolling machine of a bakery, and the skin divided at the wrist, just as cleanly as if it had been done by intention, and an entire glove of the skin taken off. When I saw it, it was held on by the tips of the fingers only. There was no injury other than that described. I felt satisfied that amputation was proper; but the patient insisted that he was willing to take the risk if amputation was not performed, and I replaced the flap, and stitched it in several places, believing that it would slough. It did slough, and he lost his fingers up to the knuckles, and the only part that was saved was a small portion of the thumb, and the metacarpal portion of the hand. This, of course, was a cicatricial surface which I covered with grafts, and it finally healed. The boy can hold a pen in a little groove by the side of the thumb, and it is probable that the remnant of the hand will finally become useful.

The explanation of the certainty with which the stripped-off skin dies in these cases, and the uselessness of the most careful stitching, lies in the fact that not only have the vessels passing from the deep parts to the skin been torn through, but the skin itself has been submitted to an enormous strain and dragging.

In such cases where it is clear the glove-like skin must go, an attempt should be made by skin-grafting, after Thiersch's method (*q.v.*), to provide a covering, and prevent the sloughing of the deeper parts.

v. The above is especially to be made use of where, after an injury to the hand, it may be possible to save one or two fingers only, or, particularly, the thumb and index-finger, by taking skin, if possible, or a pedunculated flap, from the damaged hand, from the opposite arm or the belly, or, as I prefer, by large grafts taken by Thiersch's method, *q.v.*, from the shoulder. Dr. Schreiber (*Münch. Med. Woch.*, Aug. 19, 1892) advises skin-grafting in smaller injuries. Thus, if the skin be torn away from the dorsum of a finger, over-extension will follow when the wound is healed unless it is grafted. On the other hand, if it be the pulp that be torn away, successful grafting will give a rounded, sensitive, fleshy end, instead of a thin, sensitive, pointed one. The surgeon must, of course, prepare his patient for disappointment. The grafts may die, and the injured part be reduced to a claw, active movement largely disappearing. Skin-grafting may also be made use of later on if one or more fingers become contracted, and division of the cicatrix leave a gaping wound.

vi. **Injury to Joints.**—Where the tendons are uninjured, or can be sutured, where there is no extensive comminution of bone or great injury to the skin, the part will, of course, be saved. If expectant treatment is adopted, even if the parts heal quickly, the surgeon will be fortunate if he manages to preserve for his patient half the natural range of movement of the joints affected. And to do this splints will have to be frequently changed, the part being put up for a short time flexed, then extended, massage assiduously employed, &c.

I am of opinion that excision of a joint which has been freely opened will restore better movement if the patient is brave and persevering. It should certainly be tried—and removal of the bones carried out sufficiently widely to prevent any risk of recurrence—in the case of the joints of the thumb (p. 13).

vii. **Injury to Tendons.**—This is fully considered at p. 27.

viii. To sum up the chief points:—Primary amputations, especially what may be called typical operations, are only to be made use of under the very rarest circumstances; any surgeon making use of them will almost always find that he has overstepped what was absolutely needful. The part should be thoroughly cleaned (with the aid of an anæsthetic), by means of turpentine and soap, with a nail-brush, and lotio hydr. perch. (1 in 2000), and the hopelessly damaged soft parts trimmed

and drainage provided. It is only by great care here that the surgeon is justified in submitting his patient, during the attempt to save a mangled part, to the risks of sepsis, gangrene, tetanus, &c. If there is any doubt as to the completeness of the cleansing, the part should be kept in an arm-bath with a weak aseptic lotion, constantly renewed. But it is always advisable to get the wound sweet and safe under adequate dressings, and at rest on a splint as soon as possible. If any part must be amputated, any flap of skin or tendon that may be useful is to be transferred to the parts that are being saved. So, too, later on, if a surface is left, which by cicatrising slowly will lead to distortion, or if tendons exposed have fibrillated and died, an attempt must be made to cover the one by flaps taken close by or from a distance, and replace the other by distance-sutures (p. 31). Secondary operations will also include removal of any painful stumps, especially those which interfere with the approximation of the thumb to another finger,

The following (Fig. 10) is an excellent instance of what may be effected by conservative surgery here. It represents the relic of

FIG. 10.



a hand, consisting of the thumb, stump of the index and of the little finger, and also shows how much flexion the shortened index is still capable of.*

RE-UNION OF SEVERED DIGITS.

The question will sometimes arise as to the advisability of attempting to re-unite portions of severed fingers and thumbs.

* The figure is taken from a paper on Railway Injuries, by Dr. Thomson, of Kentucky.—*Trans. Amer. Surg. Assoc.*, vol. ii. p. 190.

Many such successful cases have occurred, and the surgeon may well make the attempt, when the parts are cleanly severed, through a phalanx, especially the distal one; and when the patient is young and healthy, as is often the case in country practice; when the cut has passed through a joint, not through a phalanx, the outlook is far less promising.

The following are instances of the parts severed:

The first, second, and third fingers cut off above a diagonal line beginning in the middle phalanx of index finger and ending in last phalanx of third finger near the root of the nail. The parts had been lying in the snow for some time and were kept for two or three hours before being applied. In other cases the part has been severed longitudinally, containing in it a portion of bone split off. The time between the injury and the treatment has varied from twenty minutes to three or four hours, and the severed part has been picked out of sawdust, brought up in dirty paper, whilst in a third the patient was sent back to find it in the field in which he had been reaping.

When there is the least shred of soft parts left holding on the severed bit, even a bad compound fracture of the finger with severe laceration of the soft parts may be saved.

The age and condition of the patient, the time which has elapsed since the injury, the part affected—*i.e.*, whether index or thumb—must all be considered. And in any case the patient should be warned that, though the attempt may succeed, the parts unite, and sensation be restored, the result may be a stiff and therefore comparatively useless member.

If it be decided to make the attempt, the part should be well cleansed with hot mercury perchloride solution (1 in 2000), united exactly with a few points of fine wire or carbolised silk, and horse-hair sutures, enveloped in aseptic wool, and kept *in situ* with carefully adjusted splints of whalebone or perforated zinc. The dressings should not be disturbed for three days, if possible.*

WEBBED FINGERS (Figs. 11 and 12).

These should always be remedied as soon as possible in early childhood; if left untouched, the fingers may be useful, but the annoyance of the deformity will be serious.

1. The simpler methods—*viz.*, wearing a large metal ring through a hole made where the cleft should begin, or passing large silver wire or fine drainage tubing through such a hole, the ends of the tubing or wire being attached to a wristlet or bracelet—may be tried first, and the above india-rubber has the advantage of allowing the hand to move more freely. When the perforation is soundly healed, the web should be slit up, each half split,

* Numerous cases of this kind will be found in the *Lancet* for 1861, vol. ii., and later (*Annals of Surgery*, March 1887, p. 263) fifteen such cases, with good results, have been tabulated by Dr. Pilcher.

dissected up for a little way, and the edges of the two flaps thus formed united with a few points of sterilised horsehair. The fingers should be kept apart throughout the healing.

2. If the above fail, one of the following plastic operations should be made use of:

NORTON'S* (Fig. 11).—Small triangular flaps are raised between the knuckles on the dorsal and palmar aspects; the webs are then cut through and the knife carried back so as to sever all the tissues up to the bases of the flaps, which are then very carefully stitched together without tension. The object is to ensure rapid

FIG. 11.



Norton's operation for webbed fingers.

FIG. 12.

Didot's operation for webbed fingers.
(Reeves.)

union in the commencement of the cleft, and thus no re-development of the web. The flaps should be thick enough to avoid risk of sloughing, and somewhat narrow to prevent bulging. To prevent tension they should be sufficiently long, and any tissue between the knuckles that prevents their coming together should be cut away. The line of the natural web should be carefully observed.

DIDOT'S † (Fig. 12).—Two narrow longitudinal flaps are dissected up as thick as possible from the palmar and dorsal aspects of the affected fingers, and each flap is then folded round to cover in the raw surface of the finger to which it is attached, and secured with a few points of very fine interrupted sutures of carbolised silk and horsehair.

* *British Medical Journal*, 1881, ii. 931.

† A good account of these operations will be found in Mr. Reeves' *Orthopædic Surgery*.

In this operation some difficulty will be met with—(1) in dissecting up the flaps sufficiently thick in parts so small without injuring the tendons; (2) in fitting them neatly at the roots of the fingers (Fig. 12); (3) in securing sufficient skin for both fingers. I prefer Norton's operation, on account of its simplicity.

CONTRACTED PALMAR FASCIA (Figs. 13 and 14).

It is well known that occasionally contraction of the palmar fascia takes place, especially that part of it going to the inner two fingers, being due partly to constitutional, partly to local, causes. Commencing about the transverse palmar creases, it steadily cripples the hand by drawing down the fingers, causing flexion at the metacarpo-phalangeal and inter-phalangeal joint (Fig. 13).

Operation.—This may be either subcutaneous or open; I much prefer the former.

A. The Subcutaneous.—The best is Mr. Adams' method,* by multiple punctures from the surface downwards. Finding some spot where adhesion of the skin to the fascia has not yet taken place, the surgeon, avoiding the site of the vessels, passes a delicate fascia-knife, or a fine, small tenotomy knife, between the skin and fascia, and divides the band from above downwards, taking care not to dip the point. If the punctures are made where the skin is adherent they will gape widely when the fingers are straightened. In cases of contraction of two fingers, multiple punctures—*e.g.*, five to nine—may be required. It is very easy, by operating on the palmar cords, to rectify the contraction at the metacarpo-phalangeal joint. The straightening of the contraction often met with between the first and second phalanges is much more difficult. The digital prolongations of the fascia may be divided by punctures in the web between the fingers, extreme care being required to avoid the digital vessels and nerves by not dipping the point. But when the surgeon finds some difficulty in correcting this contraction thoroughly, I am of opinion that he will act most wisely by correcting the remaining contraction gradually by the use of Mr. Adams' finger-splint with rack and pinion movements opposite the metacarpo-phalangeal and inter-phalangeal joints.† When the punctures are made, they are dusted with creolin and boracic-acid powder, covered with sal-alembroth gauze, and the hand placed on the above splint, which is worn day and night at first, carefully padded at all pressure points. Some weeks will be required to correct the phalangeal contraction, and in advanced

* *Finger Contraction and Depressed Cicatrices* (Churchill, 1892).

† *Loc. supra cit.*, Fig. 10. Other splints will be found figured by Mr. Adams, *Lancet*, 1891, vol. ii. p. 166. Mr. Anderson (Hunt. Lectures on "Contraction of the Fingers and Toes," *Lancet*, 1891, vol. ii. p. 58) uses plaster of Paris for rectifying the position of the fingers at once, when the skin is sound. If this has been much strained, the straightening should be deferred for a few days.

cases relapses can only be prevented by the persevering use of the splint. If the surgeon attempts to straighten completely an advanced case of phalangeal as well as metacarpo-phalangeal contraction, he runs the risk (1) (by dividing a digital nerve) of causing slight gangrene of the finger-tips or most intolerable pain and (2) of damaging the tendons, for sometimes these bands are closely related to the theca in the fingers.

For fear of relapses the patient should, regularly and methodically, practise active and passive movements of the joints, wear the

FIG. 13.



splint at nights for a time, and if any persistent or recurrent bands threaten to be troublesome, treat these by blistering and rubbing in oleate of mercury.

Figs. 13 and 14* represent a right hand crippled with contraction of the palmar fascia, before and five years after operation. The man was a patient of Dr. J. E. B. Burroughs, of Lee, and was operated on by me in 1883, the contraction of the metacarpo-phalangeal joints being straightened at once after numerous

* The asterisks in Fig. 14 show spots where the fascia knife might be introduced in contraction of the palmar fascia slip going to the ring finger. The contracted band or bridle, thus isolated by the punctures, undergoes softening and atrophy.

punctures made in the manner above given, while that at the inter-phalangeal joints was remedied chiefly by the persevering use of Mr. Adams' splint, already alluded to. In 1890, the fingers were absolutely straight, perfectly mobile, and free from the slightest tendency to contraction. It will be seen from Fig. 14 that some thickening, puckering, and corrugation of the palmar skin and fascia still persists, but this had now no power of producing contraction, the patient, one of the relieving officers to the Lewisham Union, being able to write, &c., without any

FIG. 14.



hindrance whatever. But to show the importance of persevering in the after-treatment mentioned above, when, after another four years, I again saw the patient in 1894, there was some recurrence of the flexion of the inter-phalangeal joints. The above advice, on which I had insisted, had been entirely neglected.

B. Operation by Open Wound.—If this be preferred, the method of Goyrand may be made use of. It is recommended by Mr. Hardie,* of Manchester, who believes that mere subcutaneous division of the contracted palmar fascia cannot be sufficient if the thickened, puckered, hardened skin is left alone, and also that

* *Medical Chronicle*, vol. i. No. 1. p. 9. A diagram of the different incisions, which may be found useful, according as the band is linear or branching, is given by Mr. Anderson (*loc. supra cit.*) *Lancet*, 1891, vol. ii. p. 59.

intimate adhesion of the altered skin to the fascia is so general that it is difficult, if not impossible, to get the knife between the two at a sufficient number of spots for adequate straightening by the subcutaneous method. While it may be readily admitted that Mr. Hardie's four cases gave good results up to the time reported, and that, if any open operation is really needed, this one is as good as any, I think that the following are objections to its general adoption in preference to that of Mr. Adams: (1) The greater severity of an open operation in these patients, who are often not young, even when the wound is, by hands as careful as Mr. Hardie's, kept aseptic. (2) The more frequent dressing, the need of a drain, the fact that the wound does not heal for upwards of a week, and then, perhaps, not all by primary union; the presence of sutures which need removal, and the fact that, as in Case III., "general swelling of the hand" may take place and interfere with the use of splints. Finally, Mr. Hardie does not appear to me to attach sufficient importance to the value of Mr. Adams' splint, which, by gradual, quiet, persevering extension, causes atrophy of the now divided fascial cords, and thus renders, as a secondary result, the hardened skin over them more soft and supple, this taking place the more readily, the more extension by the splint, and passive movements, frictions, &c., are persevered with.

PALMAR HÆMORRHAGE.

There are three arterial arches especially concerned in keeping up the arterial supply here—viz., (α) superficial palmar; (β) deep palmar arch; (γ) the carpal arteries around the wrist. These are supplied with blood, not only from the radial and ulnar, but also from the interosseous arteries. Finally, if the *comes nervi mediani* is enlarged, it will join the superficial palmar arch, or one of the digital arteries.

Treatment.—This will vary accordingly as the case is seen early, or later.

A. EARLY CASES.—The surgeon arrests any bleeding* by pressure on the bleeding-point while he has the limb raised, and arranges for compressing the brachial, or the radial and ulnar. This securely effected, he cleanses the wound, dries it carefully, and, if it gapes at all, endeavours to secure the cut vessel itself. If this fail, or if the wound be merely punctured, he at once carefully applies compression. And it may be said at once that, if this is wisely and efficiently done, no further hæmorrhage will

* The wound sometimes does not bleed when examined. If there is a history of much bleeding, bleeding *per saltum*, if the depth, &c., of the wound make it probable that an artery is wounded, pressure should be applied. A little later, and the hæmorrhage may break out on the least exertion; this is very likely to occur at night.†

take place; if incompletely or carelessly applied, the patient's limb and life may both be endangered.

The brachial being commanded and the wound cleansed, a compress—consisting of boracic lint, dusted with creolin and boracic acid powder or iodoform, pieces of sponges wrung out of carbolic acid, and dusted with iodoform and powdered steel sulphate, or lint soaked in carbolic oil or tr. benz. co., the pieces of lint or sponge increasing in size from a threepenny bit to half a crown—is got ready, together with strapping, bandages, lint, and two bits of pencil or bougie. The fingers are now carefully strapped and bandaged, and the compress is then secured in position by careful bandaging. If the above precaution is omitted, so much and so painful oedema of the fingers will take place, as to inevitably lead to early removal of the compress and recurrence of the hæmorrhage. The compress being in position, two bits of pencil wrapped up in lint are placed over the radial and ulnar, and the bandage carried up to mid-arm. The Esmarch's bandage being removed from the brachial, a splint is then applied, and the patient kept at first well under the influence of morphine. The compress should not be disturbed for three or four days at least.

B. LATER CASES.—If pressure has been tried, but inefficiently because inadequately at first, inflammation will probably have supervened, and the hand will very likely be red, brawny, painful, suppurating. If hæmorrhage still continue after the parts are relieved by carefully made incisions* it will be wiser to tie the brachial artery at once in the middle of the arm (p. 83) than to tie the radial and ulnar in the lower third of the forearm (pp. 51, 53), and for these reasons:—

i. While the anastomoses round the elbow are so free and so reliable as to prevent any risk of gangrene after a ligature of the main vessel, ligature of the radial and ulnar is rendered uncertain owing to—

(a) The anastomoses between the two palmar arches; (β) The anastomoses between these and the carpal arteries; (γ) The blood brought down by the interosseous arteries and the comes nervi mediani, which will not be stopped by ligature of the radial and ulnar; (δ) The fact that, if inflammation has set in, enlargement of the arteries will have taken place.

ii. Ligature of the brachial, by cutting off so much blood, will also cut short the inflammation.

iii. Ligature of the brachial will be performed through healthy and uninflamed parts.

An interesting instance of what pressure will effect even if deferred till the eleventh hour is seen in the following case:

* Incisions for suppuration in the hand should be made opposite to the centres of the phalanges, opposite to the heads of the metacarpal bones, above the superficial palmar arch by Mr. Hilton's method, and, if above the wrist, the position of the arteries, which may, perhaps, be superficial, and of the median nerve, lying close to the inner side of the palmaris longus, must be remembered.

A patient nearly three weeks after the wound, having had attacks of recurrent hæmorrhage, entered St. Bartholomew's Hospital, and Mr. Skey tied the radial and ulnar. When the ligature separated from the ulnar, hæmorrhage took place, and the artery was again tied in the middle third. Hæmorrhage recurring, the brachial was tied in the lower third. This last operation failed to arrest the hæmorrhage, and the third part of the axillary was tied. About ten days later profuse hæmorrhage from the axillary wound left the patient almost pulseless. The patient's condition not admitting of amputation at the shoulder, the limb was firmly bandaged from the hand to the shoulder. No further bleeding took place, and the man made a good recovery, with a useful arm. (*Lancet*, 1855.)

In the *Lancet*, 1859, vol. i. p. 506, is a good instance of the results of pressure inefficiently applied:

The compress, which had been applied to the palmar wound (the man having been made an out-patient), was removed every day, and followed by hæmorrhage. Severe bleeding occurred on the fifth day, ligature of the radial was performed on the seventh, and on the ninth ligature of the brachial lay down. On the eleventh, owing to recurrence of hæmorrhage, the arm was amputated just above the ligature. Chronic pyæmia followed, from which the patient was slowly recovering at the close of the report. No abnormal distribution of vessels was found in the arm.

PALMAR GANGLION.

Practical Points.—(1) There is the risk of spreading sepsis if the wound be not kept carefully aseptic. (2) Recurrence is very frequent, from the fact that it is difficult to remove all the melon-seed bodies which are often present in great abundance. However few may be left behind, these will suffice for continued effusion of fluid, weakening of the ligaments,* and, perhaps, ultimate disorganisation of the joint. (3) This form of ganglion is occasionally tubercular. In these cases disease of the carpus is almost certain to follow.

Treatment.—This will vary according as the disease is recurrent, inveterate, or tubercular.

A. In cases where the disease is not tubercular, where it has resisted palliative treatment, but has not been operated on before, simpler steps should be first tried. The parts being rendered aseptic, an incision should be made $1\frac{1}{2}$ inches above the anterior annular ligament, avoiding the median nerve, and going down into the ganglion, the deep opening into which is not to be a mere buttonhole, but must be kept free and dilated, otherwise the complete carrying out of the next step, on which a cure depends, will be found impossible. This consists in removing all the melon-seed bodies, partly by pressure, partly by the use of a sharp spoon, which should explore all the cavities into which these

* If for any reason the operative treatment of compound ganglion is deferred, some well-adjusted form of support and compression should be worn, otherwise delay will lead to dangerous stretching of the ligaments and weakening of the joint.

ganglia are sometimes divided. Thus care should be taken to examine and treat, if needful, the synovial sac enveloping the flexor profundus as well as that in relation with the superficial flexor. The question of providing a second opening below the anterior annular ligament will now arise. Where the ganglion is a large one, where the melon-seed bodies are numerous, where it is desirable to provide thorough drainage, a second opening should be made. This may be safely done by passing a bullet probe from the upper opening under the annular ligament, and cutting down upon it through the palmar fascia, the palmar arch being avoided. This opening being enlarged with dressing-forceps, the sharp spoon is again applied, if needful, and when, either by this means, or by rubbing a strip of iodoform gauze wrung out of 1 in 20 carbolic acid between the openings, all the melon-seed bodies are detached and removed, the cavity is washed out with a solution of carbolic acid (1 in 40), hydr. perch. (1 in 2000), or zinc chloride (gr. x to ʒj)—whatever fluid is used the greater part of it must be withdrawn—and then a drain of sterilised horsehair is passed by means of the probe from below upwards. Strands of this may be withdrawn as needed. The hand may be conveniently put up with the fingers flexed, as on a Carr's splint. All should be healed in three weeks, at which date movements, which may be cautiously begun before, should be actively persevered with.

B. Where the disease recurs, or where there is reason to suspect tubercular mischief, further steps will be required in order to prevent the mischief extending to the carpus. The ganglion being opened by the steps given above, its walls will probably be found to be thick and velvety, with vascular fringes over the tendons. In such cases each of the tendons must be separately hooked up and cleaned with scissors and dissecting forceps. To eradicate the whole of the tubercular mischief it will probably be needful to divide the anterior annular ligament, the position of the median nerve being first carefully noted. In spite of the weakening of the hand that will follow, where there is reason from the family or personal history, the obstinacy of the disease, the aspect of the interior of the ganglion, to suspect tubercular mischief, the incision must be boldly made from about $1\frac{1}{2}$ inches above the annular ligament down through this structure to a point just above the level of the superficial palmar arch. Otherwise there is danger that, by insufficient exposure of the parts, persistence of the tubercular mischief, and, ultimately, disease of the carpus, is courted. When by the use of the scissors or sharp spoon all the mischief has been eradicated as thoroughly as possible, the surgeon examines for the presence of bone disease, flushes out the parts with the above solutions, followed by a good dusting in of iodoform, or instead of the above fluids a thorough rubbing in of powdered iodoform made into a paste with lotio hydr. perch. 1 in 1000. During the operation every bleeding-point

must be arrested by ligature with fine chromic gut. The use of forci-pressure is less advisable owing to the risk of damage to the tendons. The annular ligament is then united with buried sutures of chromic gut, or kangaroo-tail tendon, and dressings applied with even pressure, so as to distribute the discharges, which will probably be free, through as wide a surface as possible.

After this operation movement of the fingers must be begun as early as possible, to prevent the tendons being matted together after all the interference needful at the operation.

OPERATIONS FOR UNION OF DIVIDED TENDONS.

I propose to speak first of some general points in the union of divided tendons, and then to deal with some special methods of suture.

As in the case of divided nerves, the union of tendons may be primary or secondary, according as the surgeon is called to the case at once or later.

The upper end will probably give more trouble than in the case of a nerve, owing to its greater retraction. In laying open the sheath to follow up the tendon, most scrupulous care must be taken to use every aseptic precaution, especially where the parts are much disturbed, the sheaths extensively opened, &c., otherwise a retracting tendon may carry septic matter up into its sheath. If suppuration and slow healing follow, there will be a large thick scar in which all the subjacent structures will be blended in one mass.

I always prefer to make the parts evascular beforehand with Esmarch's bandages, though this step has been objected to as likely to lead to after-oozing, tension, &c. To meet this, every vessel that can be seen should be carefully secured, the wound thoroughly dried out, and then, after the wound is sutured (but not over-closely or tightly), thick dressings should be applied before the Esmarch's bandages are removed.

Sutures of thoroughly sterilised silk are preferable to those of chromic gut, which are always liable to give way too soon, especially if suppuration occur. Large tendons may be secured with two lateral, or one central and two lateral sutures, smaller ones with one only. They must be tied carefully, without undue tension, otherwise they will cut through quickly. The sheath, especially where this must be opened to find the proximal end, must be interfered with as little as possible, as in it run the vessels on which the repair of the tendon-ends depends. The limb must be put up on a splint in such a position that no undue tension falls upon the united tendons, while at the same time the comfort of the patient is attended to. Restlessness of the patient as the anæsthetic is passing off must be prevented, as, if the sutures do not hold, the

parts will tend to heal in one contracted mass. Most careful attention will be needed afterwards by means of persevering, passive and active movement, the former being begun about the fourteenth, and the latter about the twenty-first day. Full advantage must also be taken of friction, massage and faradisation so as to keep the tendon free and to secure full range of movement.

The above remarks refer to an uncomplicated case of tendon-suture. As with nerve-suture, so with that of tendon, great difficulties may arise as to the following points. (1) **Is the tendon completely divided?** (2) **Finding the upper end;** (3) **Getting the ends apposed or approximated as closely as possible;** (4) **Preventing excessive tension.**

(1) **Is the tendon divided?**—Swelling may prevent the patient from moving one or more fingers. If it be a flexor which is probably wounded, the surgeon should bring down the affected finger and see if, when the pressure is removed, the patient can himself keep it flexed. Electricity is sometimes useful. An exploratory incision will clear up the point.

(2) To meet the difficulty, sometimes extreme, of **finding the retracted upper end**, M. Félizet (*Bull. et Mém. de la Soc. de Chir.*, t. xix. p. 610, 1893) advises that if slitting up the sheath and pressing down the muscular belly are insufficient, the upper end may be made to emerge into view, and further disturbance of the parts avoided, by extending the adjacent fingers. By this step what M. Félizet terms the little fibro-serous vincula, which tie together adjacent tendons, are drawn upon and pull down the upper end of the severed tendon into view. If after careful search, sufficient slitting-up of the sheath, &c., it is still found impossible to find the upper end, the lower end may be successfully attached to a neighbouring tendon, the lateral margins of each being suitably prepared.

The following case (Dr. v. Fillenbaum, *Wien. Med. Woch.*, Nos. 29 and 30, 1885) is a good instance of the success of the last step, and of one means of preventing tension.

Oblique cut with a bread-knife, involving the common extensor of the index and middle finger, and the extensor indicis, the central end of the latter retracted so far that it could not be reached, unless by slitting up its sheath. The tendons of the common extensor were each united by two fine silk sutures.

The accessible peripheral end of the extensor indicis was attached to both ends of the sutured tendon from the extensor communis to the index finger. The strongly stretched extensor tendons of the second and third fingers were now fixed (to prevent retraction by muscular action) by silk sutures passed, 2 cm. higher up, through skin and tendon sheath, and tied over a roll of iodoform gauze. These were removed on the fifth day. Passive movement was begun on the sixteenth day. Six months later the man had perfect use of his fingers.

Where the approximation of the two ends is found extremely difficult or impossible, the surgeon will resort to one or more of the following:

- i. **The ends of the tendon-sheath should be united, in**

the hope that re-formation of tendon will take place in the canal thus formed. With this view, in the case of secondary tendon-suture, the ends of the sheath must be refreshed and all scar-tissue removed, in the hope that the same formation of new tissue may take place from the vessels of the sheath as is known to take place after tenotomy.

ii. **Tendon-lengthening.**—(A) One of the ends of the tendon may be slit longitudinally, for the needful distance, nearly to the end, and the detached half turned down and united to the other end, either directly or laterally (Fig. 18). If not subjected too early to strain, the resulting tendon will be sufficiently strong to perform its functions.

(B) Where the tendon is thick and rounded, the following method of tendon-lengthening may perhaps be made use of: In flat and

FIG. 15.



One method of tendon-lengthening. A. Tendon split longitudinally. B. Section completed by incisions at ends of fissure. C. Divided tendon elongated and sutured. (Anderson.)

easily frayed-out tendons, sloughing would probably follow on so much manipulation of each end. The gap that remains between the two ends of the tendon having been carefully measured, each tendon is split accurately in the middle line, care being taken not to bring the split too near to the end of the tendon. At the two ends of the above incision section of the opposite halves of the tendon is made, as at Figs. 15 and 16.

The two cut ends are then made to slide past each other, and are stitched together for a distance of half an inch. If the primary split in the tendon has been made two inches long, and if each end of the tendon is submitted to the above process, two inches will be gained before the thus lengthened ends of the tendon are sutured together.

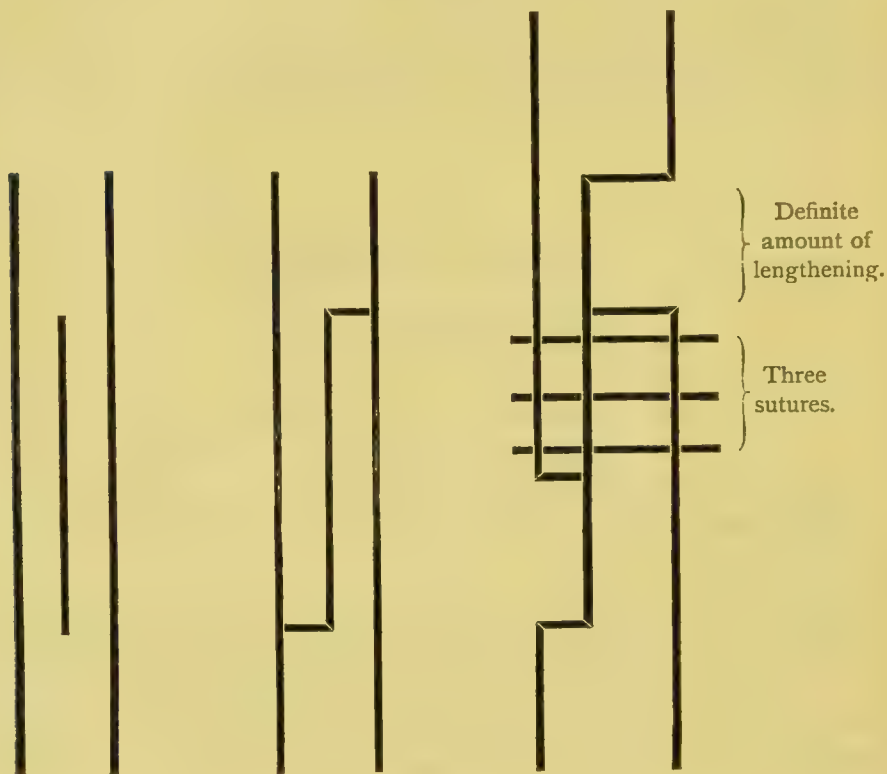
Tendon-lengthening will also be found useful in certain cases of contracted tendons—*e.g.*, where the flexors of the fingers are contracted, but without any spastic or paralytic complications from disease of the nervous system above, conditions which would interfere with a successful after-result, however carefully the tendons were lengthened and united. Again, for the success of this method the tendons operated on must be healthy, or at least free from much inflammatory matting, a condition which will prove

obstinately recurrent, while the manipulations needful to free the tendons at the time of operation are very likely to produce sloughing.

Fig. 15 is taken from Mr. Anderson's Hunterian Lectures on "Contractions of the Fingers and Toes," *Lancet*, 1891, vol. ii. p. 108.

Fig. 16 is taken from a paper by Prof. Keen (*Trans. Coll. of Physicians of Philadelphia*, 1891), and illustrates the same method.

FIG. 16.



Tendon-lengthening. (Keen.)

Tendon-lengthening by Zigzag Incisions (Fig. 17).—M. Poncet of Lyons has shown (*Gaz. Hebd.*, 1891, p. 575) that this method may be successfully employed in cases where, owing to the tension, the threads which have been inserted in the ends of the tendons threaten to cut through.

In the first case, that of a boy whose tendo-Achillis had just been severed, M. Poncet, in order to diminish the tension necessary to bring the ends together, made, on the upper end of the tendon, two cuts in zigzag fashion, each passing a little more than half across the width of the tendon. Marked elongation of the tendon followed, and it was then easy to suture the ends without tension. The boy was allowed to walk on the twenty-eighth day, and left the hospital about seven weeks after the injury, walking being almost perfect.

While this method is especially applicable to the tendo-Achillis

from its size, M. Poncet has also used it in the case of the extensor indicis.

In this case also two zigzag incisions on the upper end of the tendon enabled the suture, which had previously threatened to cut out, to be inserted without any tension.

The incisions should pass through at least half the width of the tendon, and include both this and its sheath. There is no risk of the tendon sloughing, if antiseptic precautions are taken.

iii. Where the ends are so widely apart—as after the removal of a growth—that apposition by the above methods is impossible, long threads, **distance-sutures**, may be employed to connect the ends with hope of success. MM. Anger and Assaky (*Rev. de Chirurg.*, Nov. 1886) were among the earlier workers on this subject. More recently M. Glück seems to have employed it with marked success in several cases. Two are reported (*Semaine Médicale*, 1892, p. 198).

(1) A man in whom the two ends of the flexors of the middle finger were widely separated after an injury. Here M. Glück was able to remedy a gap of 10 cm. (= 4 in.) by substitution of threads of silk and catgut. Healing by first intention and perfect restoration of movement followed. It was thought that in this case gradual substitution of the catgut by connective tissue took place.

In the second case this method was used not for filling up a gap in the tendon, but for replacing an end which was lost.

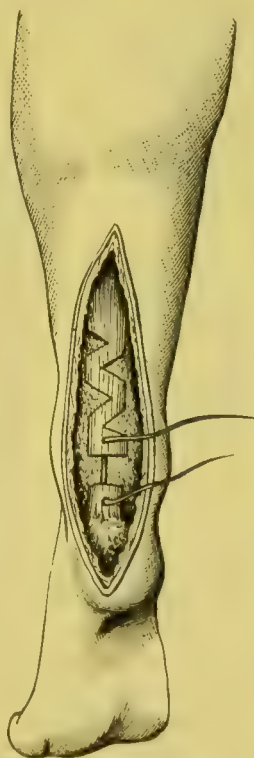
(2) A boy suffered from injury to the tendons of the extensor indicis and communis. M. Glück firmly tied the central ends of the tendons with loops of silk, and carried them forward to their points of insertion, where they were fixed by means of a steel needle. The first trial failed, the sutures tearing out. A second operation succeeded. When the needle was removed at the end of four weeks, both the middle and terminal phalanx could be extended.

In some cases the foreign body employed in the above method is not absorbed, but is surrounded by a sheath of connective tissue. In others the bundles are gradually absorbed and replaced by fibrous tissue.

This method of distance-sutures seems to have been employed in this country as long ago as 1889, by Mr. Gostling of Worcester (*Lancet*, ii. 1890, p. 767), in a case of injury to the extensors of the thumb.

Eleven weeks before, while the patient was pruning roses, his knife inflicted a wound, the scar of which, an inch long, was found about an inch above the base of the metacarpal bone of the left thumb. Just below this scar the distal ends of the extensor primi and ossis metacarpi pollicis could be easily felt, but the

FIG. 17.

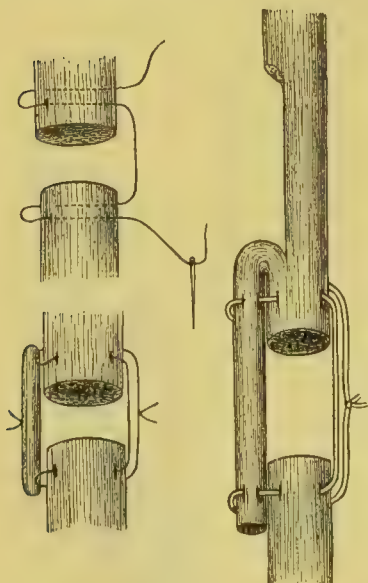


Tendon-lengthening by zigzag incisions. (Poncet.)

proximal ends could only be indistinctly made out five inches off on the back of the forearm. The left hand was of little use, the thumb being flexed and adducted into the palm. An incision exposed the distal ends at once, but the synovial sheath was blocked at the scar for three-quarters of an inch by a mass of connective tissue. This was cut through and the sheath slit up until the proximal ends of the tendon were found. All four ends were smoothly rounded off, and no adhesion had formed. As the ends were five inches apart it was impossible to bring them nearer together than three-quarters of an inch. The ends being pared they were stitched together with two catgut sutures each. The wound healed by first intention, and six months later all the movements of the thumb were perfect.

iv. Where only one end can be found, **implantation of it into an adjoining healthy tendon of the same group**

FIG. 18.



Different methods of tendon-suture. (Trnka.*). In the right-hand figure, where the ends of the tendon cannot be brought together, tendon-lengthening (p. 29) has been employed on one side, and some catgut strands—a form of distance-suture (p. 31)—on the other. In the left-hand figure a form of transverse suture is shown above, below distance-sutures, consisting of different thicknesses of catgut, have been used.

may be employed, the side of this tendon having been duly refreshed (*vide supra*, p. 28).

In 1886 Wölfer successfully combined the method of distance-suture and attaching the ends of the severed tendons to adjacent sound ones.

The patient had had all the tendons of the extensor communis severed. He was unable to extend the middle and ring fingers, but retained this power over the index and little fingers. At the operation, two months after the injury, it was necessary to divide the posterior annular ligament in order to find the central ends of the tendons. As the separated stumps were 8–9 cm. apart, direct union was hopeless. The ends were joined by indirect transverse sutures of silk and catgut, the loops being 8 cm. long. The four central and peripheral tendon-ends were also united to the adjacent uninjured tendons, two to the extensor indicis and two to the extensor minimi digiti. Though the wound healed without suppuration, the silk thread loops were cast off unaltered. Ten days after the operation the patient began to extend his fingers, and he ultimately regained extension of each individually, as in the uninjured hand. This good result must have been due to the fibrous tissue which had been developed in the place of the catgut and silk threads, and not to the joining of the tendons to those which were intact.

Dr. Wölfer (*Wien. Med. Woch.*, 1888, s. 1) claims that his method of *Transverse Tendon-suture* (Fig. 19) is simple, one that ensures exact union, and less likely than others to cut out, in cases where there is much retraction of the ends. When the ends touch he calls his method direct transverse tendon-suture, and gives it the name of indirect when the ends cannot be

made to touch, and the threads are tied and left to form guides for the development of fibrous connecting bridges.

Tendon Grafting or Transplantation.—Here a part of another tendon, where there has been extensive injury, or a tendon from one of the lower animals is made use of.

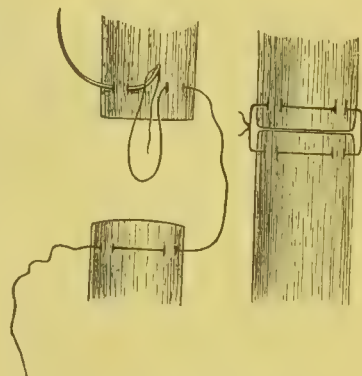
Mr. Robson (*Clin. Soc. Trans.*, vol. xxii. p. 291) successfully grafted $4\frac{1}{2}$ inches of flexor tendon from a finger too much smashed to save, on to the dorsum of the hand, so as to form a new extensor for the index finger, the tendon of which had been completely torn away. The proximal end of the tendon was stitched to the fleshy belly of the extensor communis where the tendon had been previously attached, the distal end being fixed to the small portion of tendon left near its insertion into the phalanx. The case, which is an excellent instance of conservative surgery, ended in recovery with a most useful limb. During extension of the index the new tendon could be felt to move under the skin.

M. Peyrot (*Bull. de la Soc. de Chir.*, 1886, p. 357) has succeeded in transplanting the tendon of a dog, and, in another case, that of a cat, into the gaps of divided tendons in man. The transplanted piece is said to have lived, and a fair amount of flexion of the finger to have been obtained. M. Monod (*loc. supra cit.*, t. xiii.) published a case of division of the long flexor of the thumb, in which he employed, with the happiest results, a slip of tendon taken from the hind leg of a rabbit. Whether this will be found preferable in its results to distance-sutures remains to be seen. It is doubtful how far such a graft lives, and how far its place is taken by new formation. It is a somewhat troublesome method, and renders a double suturing of the tendon needful.

Dr. V. Rochet of Lyons, has published (*Gaz. Hebdom.*, 1891, p. 293) a case in which he practised successfully a method of *tendon grafting* which he calls *autochthonous*, the graft being taken from one of the divided tendons themselves. This method is especially applicable to the flexor tendons of the fingers.

The patient had, two months before, suffered division of the flexor tendons at the root of his right index. The two lower phalanges were constantly extended, all power of flexion being lost. The parts being rendered evascular, an incision at the site of injury showed that an interval of 6 cm. existed between the cut ends of the flexor tendons, and that by no means could this distance be reduced to less than 2 cm. To fill up this gap Dr. Rochet made an incision over the lower part of the middle phalanx and the base of the last, just where the flexor profundus emerges from between the two slips of the sublimis. He divided the former, and then, returning to his first wound, drew the piece of the flexor profundus, which was now cut above and below, out into the first wound, the attachments of the tendon to the sheath yielding readily. The lower end of this tendon-slip was then sutured to the lower end of the flexor sublimis and its upper end to the muscular ends of the flexor sublimis and profundus, directly to the former tendon and laterally to the latter. Lastly, the small slip of flexor profundus, which had been left attached to the last phalanx, was sutured to the two slips of the flexor sublimis a little above its insertion into the second phalanx. The wound healed quickly, and on the fifteenth day some power of flexion was already present. Later on the

FIG. 19.



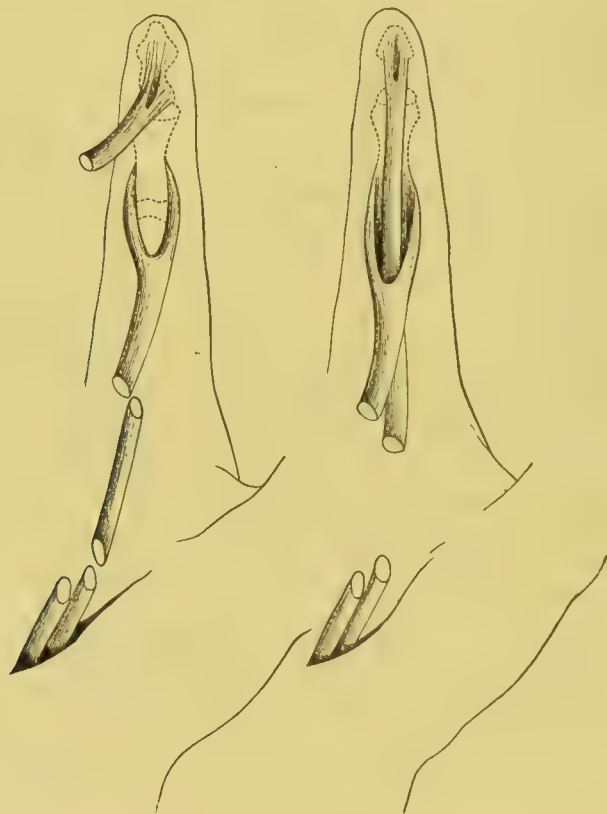
Wölfer's transverse tendon-suture.

second phalanx could be flexed as freely as its fellow. Flexion of the third phalanx was more limited, this not passing beyond a very obtuse angle.

Dr. Rochet observes that it would be possible to carry out the above method by taking the graft or slip from the upper end of one of the lower parts of the divided tendons without interfering with its insertion, which involves making a fresh wound.

Mobilisation of Tendons.—M. Poncet of Lyons (*Rév. d'Orthop.*, July 1891) made use of the following ingenious means of uniting a severed tendo-Achillis. Forty days after the injury

FIG. 20.



Autochthonous tendon-grafting. (Rochet.) To the right is seen the gap between the tendons found on exploration; to the left the manner in which it was filled up.

(by an axe) the wound was healed, but the ends of the tendon were 3 cm. apart, and the lameness was very disabling. A U-shaped flap having been dissected off the back of the heel, a slice of the os calcis was then vertically detached with the saw; when quite loose it was glided upwards and the lower part of it fixed to the upper part of the sawn surface with an ivory peg. The ends of the tendon could now be brought into close apposition without undue traction. The result was perfect.

M. Poncet points out that this method of mobilising a tendon by osteotomy and displacement of the process into which it is inserted, is likely to be useful in old cases of rupture of the liga-

mentum patellæ with wide separation ; in some cases of old fracture of the patella, in which there is great difficulty in getting the fragments together, and also in cases in which free flexion of the forearm is hindered by contraction of the triceps tendon, due either to injury or disease. It should, of course, only be performed with strict antiseptic precautions.

I may take this opportunity of saying that in the treatment of an incised wound of the hand or foot the condition of the tendons should be cleared up as well as that of the vessels. The practitioner too often rests satisfied with arresting the urgent hæmorrhage. The wound heals quickly, but loss of power remains. The following is a good instance :

In August 1888, H. P., aged thirty-one, was sent to me with a constant flexion of, and inability to extend, the last two phalanges of the thumb. A few months before he had been treated for severe hæmorrhage from an incised wound of the dorsum over the first phalanx and metacarpal bone of the right thumb. By dissection the extensor secundi internodii was found to be divided, the upper end being found by following up the sheath. The extensor primi had been only partially divided, for three-quarters of its width. After trimming, the two ends of the extensor secundi were separated by an interval of an inch on complete extension of the thumb. Use of a stout silk suture and pushing down the upper end of the tendon left the ends still separated by $\frac{1}{4}$ inch ; two very fine silk sutures brought the ends into good but not exact apposition. On hyper-extending the thumb the V-shaped notch in the partially divided extensor primi was obliterated, so no sutures were used here. The notch was merely refreshed. A horse-hair drain was inserted, the superficial wound closed with fishing-gut. Irrigation with hyd. perch. 1 in 2000 was made use of, and a splint applied on the palmar aspect so as to keep the thumb hyper-extended. Morphine was given freely. When seen two months later, the patient had recovered complete extension.

CHAPTER II.

OPERATIONS ON THE WRIST.

EXCISION OF THE WRIST JOINT (Figs. 21 and 22).

THE reasons for this operation often failing, and the conditions needful for success, may be first considered.

1. Whether the disease begins in the synovial membrane as a synovitis, pulpy, gonorrhœal, rheumatic, &c., or whether, as more rarely, it begins primarily in the bones, it extends rapidly, not only to the wrist-joint, but to the two rows of carpal bones and the bases of the metacarpals, along the complicated synovial membranes,* which bring all these bones into contiguity with each other. The disease, thus extensive, is also most obstinate, and is in adults, often further complicated by a tendency to phthisis. Thus partial operations are useless, and often worse than useless. Sir J. Lister† was the first to insist on the importance, and to show the possibility, of removing every atom of the disease, including the ends of the radius and ulna, the two rows of carpal bones, and the bases of the metacarpals (Fig. 21).

2. From the close relation of the flexor and extensor tendons in front and behind these complicated joints, and from the numerous grooves on the bones, it is most difficult to extirpate the disease without disturbing the tendons. On the other hand,

* The arrangement of these, five in number, must be remembered, and their close vicinity to each other. (1) The *membrana sacciformis* of the inferior radio-ulnar articulation, passing from the lower end of the ulna to the sigmoid cavity of the radius, and lining the upper surface of the triangular fibro-cartilage. (2) That of the wrist-joint proper, passing from the lower end of the radius and the inter-articular fibro-cartilage above to the bones of the first row below. (3) The common synovial membrane of the carpus, the most extensive of all, passing from the lower surface of the scaphoid, semilunar, and cuneiform above to the upper surface of the bones of the second row, sending up two prolongations between the scaphoid and semilunar and the semilunar and cuneiform, and also sending downwards three processes between the four bones of the second row, prolonged down into the carpo-metacarpal joints of the four inner metacarpal bones. (4) A separate one between the cuneiform and pisiform. (5) Another separate one between the trapezium and metacarpal bone of the thumb.

† *Lancet*, 1865, vol. i. p. 308. From this paper Fig. 21 and the steps of the operation are taken.

however stiff the wrist may be left, flexion and extension of the fingers is absolutely needful for the operation to be a success; hence it is imperative that, throughout the prolonged operation, the tendons should be disturbed as little as possible, a direction very difficult to follow, as their cellular sheaths are often "pulpy," and the necessary manipulations of the tendons* during the

FIG. 21.



Parts removed in excision of the wrist. (Lister.)

operation may easily lead to their sloughing, and thus to a useless "fin-like" hand.

3. Passive movement of the fingers should be begun as early as possible, and most perseveringly maintained.

For the reasons given above this operation has not found much favour with English surgeons.

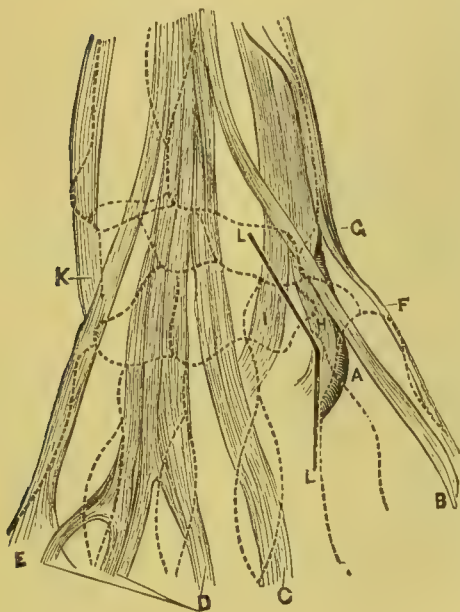
In spite of the above difficulties it is much to be desired that, as the saving of the fingers and hand is at stake, this operation should, with the advantages of modern surgery, be persevered with, and that all cases, whatever the result, be fully published. Holding the above view, I have, notwithstanding the comparative rareness of disease here, described several methods.

* Sir J. Erichsen (*Surg.*, vol. ii. p. 383) writes thus of this point: "If we look at the tendons which surround the wrist, we shall find them divisible into five groups—(1) Those special to the thumb; (2) The extensors of the fingers; (3) The flexors of the fingers; (4 and 5) The flexors and extensors of the wrist. Now, the incisions should be so planned as to save absolutely the whole of the first three groups and to divide only the tendons of the wrist proper, and these are cut so close to their insertions that, as a rule, they form new attachments, and resume their functions as recovery takes place."

1. Sir J. Lister's, with two dorsi-lateral incisions. 2. Methods with a single dorsal or ulnar incision.

Sir J. Lister's Operation.—An anæsthetic being given, and the parts rendered bloodless by Esmarch's bandages,* any adhesions of the tendons are thoroughly broken down. The hand should rest

FIG. 22.



A, Radial artery. B, Extensor secundi internodii pollicis. C, Extensor indicis. D, Extensor communis. E, Extensor minimi digiti. F, Extensor primi internodii. G, Extensor ossis metacarpi. H, Extensor carpi radialis longior. I, Extensor carpi radialis brevior. K, Extensor carpi ulnaris. L L, Line of radial incision. (Lister.)

on a sand pillow. The surgeon should be seated. The radial incision is then made, as in Fig. 22. This incision is planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed towards the inner side of the metacarpo-phalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but, on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little farther out. These directions will be found to serve, however much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by

the thumb-nail, and raised, together with that of the extensor brevior, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting forceps applied in a line with the longitudinal part of the incision, great

* Mr. Treves objects to this step as the oozing which follows the removal of the bandage is usually very considerable and, in his opinion, a great obstacle to healing. I have advised the use of the bandage because, at the time, it is most important not to have the field of the wound constantly flooded by the small vessels of the very vascular parts, this hæmorrhage imperilling the tendons, rendering the operation still more tedious by its interference with the exact carrying out of every detail which is so essential whichever method is selected. Any harm which may accrue from excessive oozing may, I think, be met, as after excision of the knee, by providing adequate drainage, using very few sutures, and enveloping the field of the wound in very ample dressings, through which the discharges shall be uniformly distributed.

care being taken of the radial artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected out without much difficulty, whereas its intimate relations with the artery and neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering the knife at least 2 inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect. The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger extensors are then separated from the carpus, and the dorsal and internal lateral ligaments of the wrist-joint divided, but the connections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pisiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones, for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist-joint is also divided, after which the junction between carpus and metacarpus is severed with cutting pliers, and the carpus is extracted from the ulnar incision with sequestrum forceps, any ligamentous connections being touched with the knife. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh ossific deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundi internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with forceps applied longitudinally.

If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.*

The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of its metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

Lastly, the articular surface of the pisiform is clipped off, the rest being left if sound, as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But if there is any suspicion as to its unsoundness, it should be dissected out altogether, and the same applies to the process of the unci-form.

The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes. Only one or two small vessels require ligature. Free drainage must be given. The hand and forearm are put up on the well-known splint of Sir. J. Lister, with the cork support for the hand, which helps to secure the principal objects in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the full extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down the adhesions under chloroform (p. 38) is maintained.

Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the forearm to the

* As an instance of what may be taken away, in one case Sir J. Lister not only removed the base of the third metacarpal bone, but drilled its shaft into a hollow tube, a sound and most useful hand being retained.

knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the forearm.*

Other Methods of Wrist Excision :

BY SINGLE DORSAL INCISION.—The following account of Von Langenbeck's operation is taken from Sir W. Mac Cormac (*Surg. Oper.*, pt. ii. p. 374),† who considers this method very superior to Sir J. Lister's, which "is at once complicated and difficult." The parts having been rendered bloodless and any adhesions broken down, a straight incision is made near the middle of the back of the wrist, the guide being the radial border of the extensor indicis tendon. The hand being slightly abducted, the incision begins close to the ulnar margin of the index metacarpal at the middle of the bone. The extensor indicis tendon should be first pushed to the ulnar side, and the soft parts incised down to the bone, which is here subcutaneous. The incision is prolonged upwards for $4\frac{1}{2}$ inches to terminate over the radius at the angle of junction of the extensor indicis and extensor secundi internodii. Over the metacarpal bone it lies along the radial side of the extensor indicis and a little higher up on the ulnar border of the extensor carpi radialis breviar, close to its insertion. The dorsal ligaments of the wrist are divided in the deeper portion of the wound, but the radio-ulnar joint should not be opened, as this makes it afterwards difficult to expose the end of the ulna. It is a matter of much importance to avoid opening the tendon sheaths. The extensor indicis is exposed in the lower part of the wound. Near the centre the extensor carpi radialis breviar is seen, and may be divided close to its insertion. The extensor carpi radialis longior is treated similarly. A little patience is now required to detach the extensor tendons from the back of the radius, especially

* Later on, when this is discarded, if the hand remains weak, I have found it useful to give support on a smaller scale by means of a leather wristlet.

† My old friend G. A. Wright, of Manchester, has made use of a similar incision (*Abstract of Med. and Surg. Cases treated at the Pendlebury Hospital*, 1884, p. 133). In a child of nine, with phlyctenular ophthalmia, enlarged glands, and many marks of strumous disease, the right wrist was disorganised. "A single longitudinal incision for 3 or 4 inches was made between extensor communis and extensor secundi, the carpal joints opened, and the bones easily shelled out; the ends of the metacarpal bones and of the radius and ulna were removed with a gouge; one vessel was twisted; no tendon was divided, except in the sense of turning back the extensors of the carpus from their attachments. Six months later, the hand, which before the operation was bulbous, flabby, and useless, was all but healed, and had well shrunken; there was excellent power and mobility." In the very young, when disease occurs in this joint, which is most rare, extensive scooping out of carious bones and scraping out of sinuses may be undertaken, although no set operation can be done, owing to the tiny size of the parts. In 1877 I removed five of the carpal bones by a single dorsal incision in an infant aged two years and a half, a patient of Dr. T. Eastes, of Folkestone, the sinuses present being thoroughly scraped out with a sharp spoon. The result was most satisfactory, both as to the permanency of the cure and the usefulness of the fingers.

those of the thumb. The soft parts are first drawn by a retractor towards the radial side, and, the capsule being split, they are raised by the elevator, the tendons in their sheaths being carefully detached from their grooves—viz., extensor secundi, extensor longior and brevior, extensor primi, and extensor ossis metacarpi. Then, by introducing the elevator on the ulnar border of the wound, the extensor indicis, communis digitorum, minimi digiti, and carpi ulnaris are also raised, their connection with the dorsal ligament on one side and the periosteum and capsule of the joint on the other being preserved; in this way all chance of injury to their sheath is avoided. The soft parts being now thoroughly elevated on both sides of the wound, we obtain, on retracting them and slightly flexing the wrist, a complete view of the articulation. The radio-carpal joint lies open, and, on the hand being further flexed, the surface of the first row of the carpus will project in the wound. The bones may be readily removed in succession with the elevator, at the same time any ligaments which impede extraction being divided with the knife. First, separate the scaphoid from its connection with the trapezium; secondly, detach the semilunar and cuneiform. Now the second row of the carpus can be removed. The round head of the os magnum is steadied with the fingers of the left hand, an assistant abducts the thumb, and the knife divides the articulation between the trapezoid and trapezium. The carpo-metacarpal joints are entered in a direction towards the ulna, whilst the dorsal ligaments at the proximal ends of the metacarpal bones are divided as the assistant flexes the hand. The trapezoid, os magnum and unciform can now be removed *en bloc*. The hook-like process of the unciform requires care during its enucleation. It may be snipped off to facilitate removal of the bone, but with a little care it can be cut out. As a rule, the pisiform bone need not be interfered with; it is generally healthy. Through it the flexor carpi ulnaris finds an insertion into the base of the fifth metacarpal, and thus forms an important connection with the abductor minimi digiti. It is better not to remove the trapezium, as it forms a separate joint with the thumb, and is usually exempt from disease. The abductor, opponens, and flexor brevis pollicis arise from it. Its extraction, besides, is not easy, as the tendon of the flexor carpi radialis runs in a groove on its anterior surface, while the radial is in dangerous proximity on its outer side. It now remains to cut off the articular surfaces of the radius and ulna. The hand being still flexed, these bones project from the wound, and with a narrow saw the ends can be quite easily removed. The external lateral ligament, with the periosteum, must be carefully detached with the elevator, otherwise the radial may be cut as it runs over the trapezium to penetrate the first interosseous space. It facilitates this step not to have previously opened the radio-ulnar joint. The resection of the radius should be as limited as possible. Finally, the

cartilages of the metacarpal bones are cut off. All gelatinous granulations should be scrupulously removed, and the wound disinfected.

In this, as in Sir J. Lister's, or any excision of the wrist, great care must be taken not to open the radial artery, not to interfere with the palmar surface more than can be helped, to preserve any sound though inflamed periosteum, not to damage the tendons* with retractors, &c., and finally to adopt early, and to persevere with, movements of the fingers.

Mayo Robson's Method by Median Dorsal Incision.

Mr. Robson (*Provin. Med. Journal*, Sept. 1, 1885), published some cases successfully treated by the above method. The chief advantage which he claims for it over that of Von Langenbeck, is that it, being more median, exposes the joint more fully.

The hand being prone, the knife is entered over the proximal end of the third metacarpal bone, carried vertically upwards for $1\frac{1}{2}$ inches, over the centre of the groove in the radius which lodges the common extensor. This extensor being identified, the knife is carried down to the bone between the tendon to the index on the outer and those for the three inner fingers on the inner side. If, as is probable, the disease be now found by the exploring finger to be extensive, the incision should be prolonged up and down, the edges retracted, and the whole joint exposed by lifting up the tendons by a raspator. The carpal bones are then removed with a small gouge or scoop, and the ends of the radius and ulna, and those of the metacarpals of the fingers, cut through either with a saw after they have been projected in the wound, or *in situ* with bone-forceps. Any sinuses are then thoroughly scraped out, and the wound drained by a tube brought out close to the tendon of the extensor minimis digiti.

Dr. Heron Watson's Method by a Single Incision on the Ulnar Side.—The method is described by Dr. Miller, of Edinburgh (*Edin. Med. Journ.*, Aug. 1894), who has made use of it ten times, and speaks of it as complete and easy.

The knife is entered about $1\frac{1}{2}$ inches above the ulnar styloid process, towards the palmar aspect, and carried down a short distance along the fifth metacarpal bone, an incision of about 3 inches being thus made down to the bone. The lower end of the ulna is then cleared, and fully an inch removed. The carpus is then exposed and removed piece by piece, the trapezium only being left. The heads of the metacarpal bones can then be dealt with by bone or saw, being turned out of the wound if necessary. Each step in the operation is very easy and very satisfactory. Very few vessels require to be ligatured. Sometimes one at the

* If any of the tendons are unavoidably so interfered with that a portion is likely to slough, it would be well to cut out this part, and unite the ends with a carbolised silk suture. And where much manipulation of a tendon is unavoidable, it would be better to divide it, and unite it subsequently.

radial side of the wound is rather difficult to secure; but as the wound can be turned almost inside out, like the finger of a glove, by pressing the thumb in, no great difficulty should really be experienced. The after-dressing recommended by Dr. Miller is packing with iodoform gauze, the amount being diminished at each dressing. In Dr. Miller's ten cases the disease did not return in five, of these the hand was "useful" in one, and "fairly useful" in four. In the other five, recurrence took place. In one, amputation was necessary; in another it was advised but not submitted to. In three more scraping was necessary (in one, twice), "a fairly useful" hand being the result.

The *advantages* claimed by Dr. Miller for the above method are: (1) A single incision. (2) Very efficient drainage, the wound being on the lower side of the limb, in the position in which the hand is most conveniently carried. (3) A scarcely visible scar. (4) An operation very easy of performance. While fuller and more precise details are required as to the amount of movement preserved in the seven hands which are described as "fairly useful," and also whether recurrence ultimately took place in three of them, such publishing of cases is most helpful.

EXCISION OF THE WRIST FOR INJURY.—This will be still more rarely required. Mr. Pye (*Med. Times and Gaz.*, 1879, vol. ii. p. 582) published a case of compound dislocation in an adult.

Some bones were protruding through a transverse rent on the front of the wrist, the radial artery was uninjured, the ulnar could not be felt. The flexor carpi radialis and flexor longus pollicis were torn across. The ends of the radius and ulna were sawn off and the carpal bones removed, piecemeal, until only the trapezium and the distal part of the os magnum, which were apparently uninjured, were left. Strict antiseptic precautions were taken, and the wound healed rapidly. There was a steady regain in power in the wrist and hand, the patient being again able to carry his milk-pails.*

Excision of Wrist for Gunshot Injury.—Dr. Otis† states that ninety-six cases of excision of the wrist, varying much in extent, were returned.

Six of these were complete, and five recovered with the functions of the hand much impaired, but all things taken into consideration, in a better condition than if they had been submitted to amputation. In the ninety partial excisions, ankylosis and extreme deformity appear to have been common. Generally the hand was strongly deflected to the radial side,‡ the fingers rigidly fixed, the skin over the projecting end of the ulna irritable and exposed to injury. "With our present experience of excisions of the wrist for injury, it seems probable that

* Sir W. MacCormac (*Dub. Quart. Journ. Med. Sci.*, 1867, p. 281) publishes the case of a girl, aged ten, in whom he removed the whole of the left carpus and most of the metacarpus, for a machinery accident, the patient recovering with a useful limb.

† *Med. and Surg. Hist. of the War of the Rebellion*, part ii. p. 999 *et seq.*

‡ As this appears to be irremediable by any apparatus, Dr. Otis suggests that it should be met by always removing the carpal end of the ulna at the same level with the section of the radius, whenever it is necessary to remove the lower end of the latter.

recovery unattended by ankylosis is seldom to be anticipated, yet that this result is not disastrous, provided the hand is in good position and the functions of the fingers are in some degree preserved." In a very few, loose, flail-like joints were observed, remediable by apparatus.

The chief English authority, Sir T. Longmore, writes thus on this operation: *

"Gunshot wounds of the wrist are usually attended with so much injury to the tendons and other structures surrounding the joint that it is scarcely possible in such cases for the operation of resection to produce satisfactory results."

Causes of Failure after Excision of the Wrist.—These are, mainly:

1. Persistent sinuses and discharge set up by remaining caries or necrosis. Sir W. Fergusson (*Path. Soc. Trans.*, vol. viii. p. 391) showed a specimen in which all the bones had been supposed to have been removed by a single incision on the ulnar side. The pisiform, trapezium, and part of the unciform had been left. The movement of the fingers was good, but sinuses remained on both sides communicating with a bare piece of radius. Death took place from phthisis. Mr. J. Hutchinson (*ibid.*, vol. xvii. p. 239) showed a specimen of wrist-joint after partial resection by Mr. Stanley. Though no active caries was present, discharge was kept up by a necrosed bit of bone in a cavity at the back of the carpus. Death here also took place from chronic phthisis. This specimen is figured and briefly described in *Brit. Med. Journ.*, 1874, vol. i. p. 11.

2. Matting and sloughing of tendons, and consequent stiffness of fingers. 3. Phthisis.

AMPUTATION THROUGH THE WRIST-JOINT

(Figs. 23 and 24).

The value of this operation has been a good deal disputed. It has been thought by some † "that it possesses no particular advantage; the length of the stump is of no great consequence; the flaps, with the numerous tendons in them, may not heal readily." Others ‡ have gone farther, and said that the long stump is found by instrument-makers difficult to fit with an artificial hand. That this is certainly not always the case is shown by Mr. H. Bigg § from two cases, one a Commander R.N., the other an artisan in the Woolwich Arsenal, both of whom, after being fitted with artificial hands, were able to engage actively in their respective employments.

As the above objections are scarcely sufficient, and as this amputation preserves, if the parts heal quickly, good pronation

* *Syst. of Surg.*, vol. i. p. 552.

† Sir W. Fergusson, *Pract. Surgery*, p. 325.

‡ John Bell, *Manual of Surgical Operations*, p. 53.

§ *Artificial Limbs and Amputations*, p. 83.

and supination, it should be practised whenever opportunities arise. These, however, as is shown below, will not be numerous.

Indications.

1. Extensive injuries (gunshot and otherwise) of a hand not admitting of the preservation of any fingers, and in which the damage of soft parts does not necessitate amputating through the forearm. 2. Disease of carpus locally too far advanced for excision, or rendered by age, condition of health, &c., inappropriate for excision. 3. Cases of failed excision. But in carpal disease the soft parts are often so much damaged by sinus formation and other results of the disease that the surgeon is driven to amputate higher up; and where this may not be the case, the articular surfaces of the radius and ulna, owing to disease, have to be removed, the operation thus ceasing to be correctly amputation through the wrist-joint.* 4, 5, and 6. More rarely still, for the results of palmar suppuration, gangrene, or burns.

Operations.—As in other amputations where the amount of skin available varies considerably, several methods will be given. The first of these is the best.

Different Methods.

1. Long palmar flap (Figs. 23, 24).
2. Equal antero-posterior flaps.
3. Method of Dubreuil (Fig. 24).
4. Circular amputation.
5. Long dorsal flap, by Teale's method.

1. **Amputation by a Long Palmar Flap** (Figs. 23 and 24).—This has the advantage of preserving skin thick, well used to pressure, and abundantly supplied with blood; the nerves are also cut square, and disarticulation is easy.

The brachial artery being secured, the hand supinated,† the wrist extended, and the thumb abducted so as to make the palmar tissues tense, an incision is made (on the left side) from the tip of the styloid process of the radius ‡ straight down well on to the thenar eminence, and then, curving across (about on a line with the superficial palmar arch §), and marking out a well-rounded

* Disarticulation has these advantages over removal of the styloid processes: (1) There is no risk of necrosis. (2) Rotation of the forearm is not interfered with. (3) The supinator longus is left to powerfully flex the forearm. (4) The stump is longer and more useful.

† If the operation is, thus, commenced from the front, the hand need only be turned over once. If the dorsum is attacked first, the hand must be turned twice, first to make the palmar flap, and secondly, to disarticulate (Farabeuf).

‡ The tip of this is nearly on a level with the intercarpal joint, being $\frac{1}{2}$ inch below and somewhat in front of the styloid process of the ulna. On a level with the latter will be found the line of the wrist-joint. The two furrows in front of the wrist are both below the level of this joint. The lower one corresponds to the upper edge of the anterior annular ligament and the intercarpal joint. If the soft parts are much swollen, comparison with, and measurements taken from, the opposite wrist will be helpful.

§ This level is usually low enough. If the parts on the dorsum are damaged, the palmar incision may be made longer. Mr. Barwell (*British Medical Journal*, August 30, 1873) advises bringing the incision as low as the crease in the palm,

of the styloid process of the ulnar. This flap is next dissected up, without scoring, as far as the level of the wrist-joint; it should contain on its under surface some of the fibres of the thenar and hypothenar muscles. If this precaution is taken, the flap will contain the superficialis volæ and ulnar arteries, and thus run no risk of sloughing.

The hand being now pronated and flexed at the wrist-joint, an incision is made slightly convex across the wrist from one styloid process to the other. The palmar flap being now retracted, the hand is strongly flexed and the joint opened on the outer side first; the soft parts in front and behind are now severed with a circular sweep (the assistant pulling slightly on the hand), the remaining ligaments divided, and the hand removed. If the articular cartilages of the radius are diseased, they must be dealt with either by gouging or, if necessary, by a clean section above the articular cartilage, a step which will interfere with free pronation and supination later on. The apices of the styloid processes should in any case be removed, but the base of that of the radius should always be left, if possible, to secure the action of the supinator longus. In amputating at the wrist-joint care should be taken, by keeping the point of the knife towards the carpus, not to open the radio-ulnar joint, nor interfere with pronation and supination.

FIG. 23.



The radial, ulnar, the two interosseous, and the superficialis volæ arteries will probably need securing. Any sinuses are now scraped out with sharp spoons, and the tendons trimmed. From the facility with which these last slip up into their sheaths, antiseptic precautions should be carefully taken.

Another Method.—This consists in marking out the palmar flap (but not dissecting it up), opening the joint by a dorsal incision as above given, and then cutting the palmar flap by transfixion, the knife being passed behind the bones. As in this method it is difficult not to hitch the knife on the pisiform and unciform bones, and to avoid a jagged edge to the palmar flap, and as the flexor tendons, being relaxed, are pulled out by the knife instead of being cut cleanly, I do not recommend it.

1. Amputation by Equal Antero-posterior Flaps.—The surgeon may be obliged, where the soft parts are scanty, to make use of this method. The objections to it are that if the tissues are thin there is some risk that the cicatrix may be adherent to

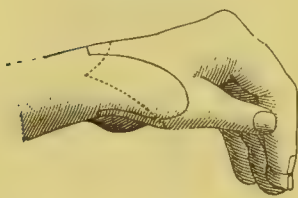
which is due to flexion of the fingers. It will be remembered that while the integuments on the dorsum retract freely, those on the front do so scarcely at all.

flap by passing upwards over the hypothenar eminence to the tip the bones, and that these will be but poorly covered. During healing the draining is less satisfactory.

3. Amputation at the Wrist by the Method of Dubreuil* (Fig. 24).—In a very few rare cases, *e.g.*, where the soft parts on the back and front of the wrist are much damaged, perforated by sinuses, &c., this ingenious method may be made use of. But the objection to it is obvious. Where the thumb is sufficiently healthy to afford soft parts for a flap, it should be saved.

The hand being pronated, the surgeon commences, at a point at the junction of the outer with the middle third of the back of the forearm, a little below the level of the wrist-joint, a convex incision, which reaches at its summit the middle of the dorsal surface of the thumb, and terminates in front, just below the palmar aspect of the wrist, at the junction of the outer with the middle thirds of the forearm. The flap, consisting of skin and fasciæ, having been raised, the two ends of its base are joined

FIG. 24.



by an incision at a right angle to the long axis of the forearm. Finally, disarticulation is performed, beginning at the radial side. If needful, the flap may be taken from the hypothenar eminence, by reversing the incisions.

4. Circular Amputation at Wrist.—

This method is only suited to patients with thin, lax skins, and even in them it is often difficult to raise quickly and neatly the skin, which is here adherent to some of the adjacent parts, as at the base of the hypothenar eminence. Moreover, cutting through these thin, lax skins may be followed by sloughing, especially if their vitality is impaired by sinuses, &c.

The hand being supported by an assistant, the surgeon draws up the skin of the forearm, and makes his first circular incision through the skin on a level with the carpo-metacarpal joints of the little finger and thumb, encroaching thus upon the thenar and hypothenar eminences, two inches below the styloid processes. The skin being retracted by freeing the soft parts with light touches of the knife, another circular sweep is made just above the level of the pisiform bone, so as to sever cleanly the numerous tendons, together with the vessels and nerves. The joint is then opened, and the styloid processes removed.

5. Amputation of Wrist by Long Dorsal Flap.—This method on Mr. Teale's principle is not to be recommended. If a skin-flap alone were taken, its poor vitality would probably end in sloughing; if the tendons are taken up as well, but little additional vascularity is gained, while the flap is inevitably somewhat ragged. If this method has to be employed, the convexity of the flap should lie over the centre of the metacarpals.

* *Précis d'Opérations de Chirurgie*, par le Dr. J. Chauvel, p. 171.

LIGATURE OF RADIAL ARTERY ON THE BACK OF THE WRIST* (Fig. 6).

GUIDE.—A line drawn from a point just internal to the apex of the styloid process to the back of the first interosseous space.

RELATIONS :—

IN FRONT.

Skin, fasciæ; branches of superficial radial vein, and of radial and musculo-cutaneous nerves; fibro-fatty tissue beneath deep fascia.

Three extensor tendons of thumb.

Radial artery
on back of wrist.

OUTSIDE.

BEHIND.

INSIDE.

V. comes. Styloid process; external lateral ligament; trapezium; carpal ligaments. V. comes.

Indications.—Few; usually wounds, *e.g.*, by the slipping of a chisel, by breaking crockery, &c. In such cases both ends† would, of course, be secured, and the surgeon would examine as to injury to any of the extensor tendons (p. 35).

Operation.—The limb should rest upon its ulnar margin, steadied by an assistant, who, with one hand, holds the fingers, and with the other so moves the thumb as to make the tendons project. In the living subject these should be thrown into action, and their position and that of the radial vein defined before the operation. The incision, $1\frac{1}{2}$ –2 inches long, may be in the above line or parallel with the tendons. In either case it should be over the lower part of the vessel, just before it dips between the heads of the first dorsal interosseous into the palm. It should be made lightly, so as not to damage the radial vein or, deeper down, the tendons. The radial vein being drawn aside with a blunt hook, and the deep fascia being carefully opened, the tendons are pulled out of the way and the artery separated from its veins. The ligature may be passed from either side. The artery lies deeper than would be expected, usually covered by fatty tissue. If the parts need relaxing, the hand should be hyper-extended. All injury to the closely contiguous tendon-sheaths must be avoided; and, for the same reason, union of the wound without suppuration is particularly indicated here.

* The so-called “*tabatière anatomique*,” a triangular space bounded externally by the extensor ossis metacarpi and extensor primi internodii, internally by the extensor secundi internodii; its apex is formed by the meeting of these tendons, and its base by the lower edge of the posterior annular ligament or base of the radius.

† Mr. Butcher (*Operative Surgery*, p. 407) states that the distal end of the artery is, after the division of the vessel, difficult to find, owing to its tendency to retract.

CHAPTER III.

OPERATIONS ON THE FOREARM.

LIGATURE OF RADIAL IN THE FOREARM (Figs. 25, 26).

IN the upper two thirds the artery is sub-muscular; in the lower third it is sub-fascial.

LINE.—From the centre of the bend of the elbow (where the artery is given off opposite to the neck of the radius) to a point just internal to the styloid process of the radius.

GUIDE.—The above line, and the inner aspect of the supinator longus.

RELATIONS:

IN FRONT.

Skin, fasciæ, viz., superficial, deep, and another layer, varying in distinctness, which ties the radial to the supinator longus and pronator radii teres.

Branches of musculo-cutaneous nerve, especially below.

Superficialis volæ below.

Transverse branches of venæ comites.

Supinator longus overlapping.

OUTSIDE.

Supinator longus.

Radial nerve (middle third).

Vein.

INSIDE.

Pronator radii teres.

Flexor carpi radialis.

Vein.

Radial artery
in forearm.

BEHIND.

Biceps.

Supinator brevis.

Pronator radii teres.

Flexor sublimis digitorum.

Flexor longus pollicis.

Pronator quadratus.

Radius.

Indications.

(1) Wounds; stabs; cuts with glass, &c. (2) Traumatic aneurism.

In these cases, the limb having been rendered evascular by Esmarch's bandages, the surgeon opens the swelling, turns out the clot, and ligatures the artery above and below. If he prefers it, he may snip out the swelling and twist both ends of the artery. The first method is, on the whole, the most generally applicable. (3) Punctured wounds of palmar arch. Ligature of the radial and ulnar is preferred by some, but I would refer my readers to the remarks at p. 24.

A. Ligature in the Lower Third of the Forearm (Figs. 25, 26).—The forearm being completely supinated and the wrist extended at first, the surgeon, seated comfortably, makes an incision, 2 inches long, midway between the tendons of the supinator longus and flexor carpi radialis, or (if there be much swelling) exactly in the line of the artery, going lightly* through the skin and subcutaneous tissue. A large branch of the radial vein, which is usually met with subcutaneous and just under the incision, is now drawn aside or divided between two ligatures. The deep fascia, here very thin, is slit up on a director, and the wrist now flexed to relax the parts. The artery being separated from the venæ comites,† the needle may be passed in either direction. Damage to any of the tendon-sheaths should be most carefully avoided.

B. Ligature in the Middle Third of the Forearm.

GUIDE.—Line of artery, p. 50.

RELATIONS, p. 50. The nerve is now on the outer side of the artery, but not very close to it.

The steps are very much as above, but the artery is lying deeper. The incision over the middle third of the artery should be fully 2 inches long, the parts well relaxed when the deep fascia is opened, the inner aspect of the supinator longus is next defined, and this muscle drawn well outwards. The layer of fascia which unites the artery to the supinator and pronator must now be opened. The needle should be passed from without inwards.

C. Ligature in the Upper Third of the Forearm (Figs. 25, 26).

GUIDE.—Line of artery, and inner aspect of supinator longus.

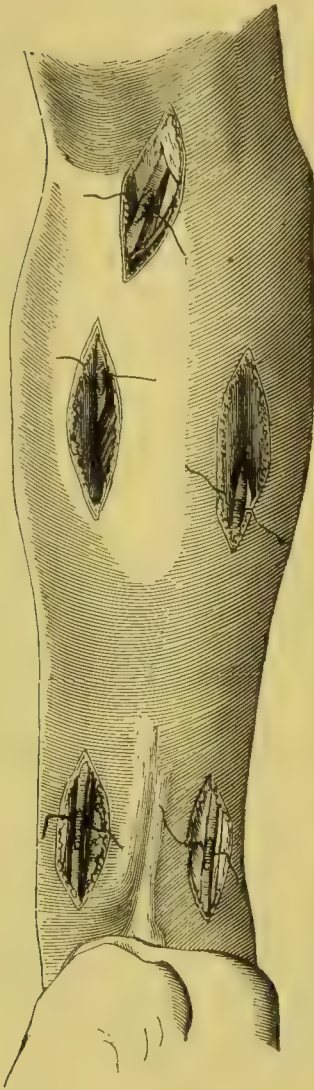
RELATIONS, p. 50. The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not

* So as to avoid the radial vein, which always, and the superficialis volæ, which sometimes, lie superficial here, just under the deep fascia, which is very thin. In the dead subject, especially, it is easy for the student to get down to or below the artery with his first incision.

† These, owing to the free collateral venous currents, may be tied in if it is found very difficult to separate them from the artery.

FIG. 25.



In the upper drawing ligature of the brachial in front of the elbow is shown. The biceps tendon is outside the artery, giving off in the upper angle of the wound the bicipital fascia; along the inner border of the wound lies the median nerve.

The remaining drawings show ligature of the radial and ulnar. In the lower two figures too much of the arteries is shown.

nator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 25), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles being relaxed by bending the elbow and wrist joints, and the cellular interval between them

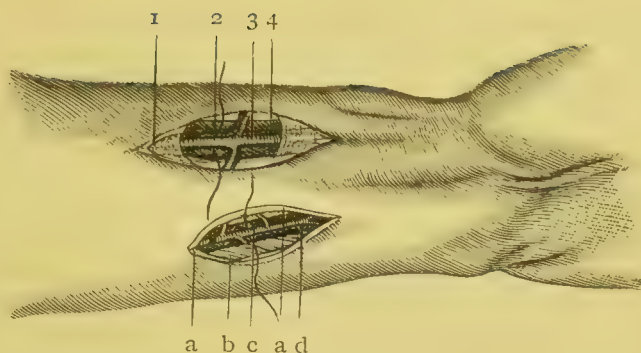
FIG. 26.



Determination of the centre of the bend of the elbow. The left index is placed upon the epicondyle, the right upon the epitrochlea, while the thumb occupies the centre of the fold of the elbow, to the inner side of the biceps tendon which projects beneath the soft parts. The line of the radial artery has been traced in its intermuscular furrow (Farabeuf).

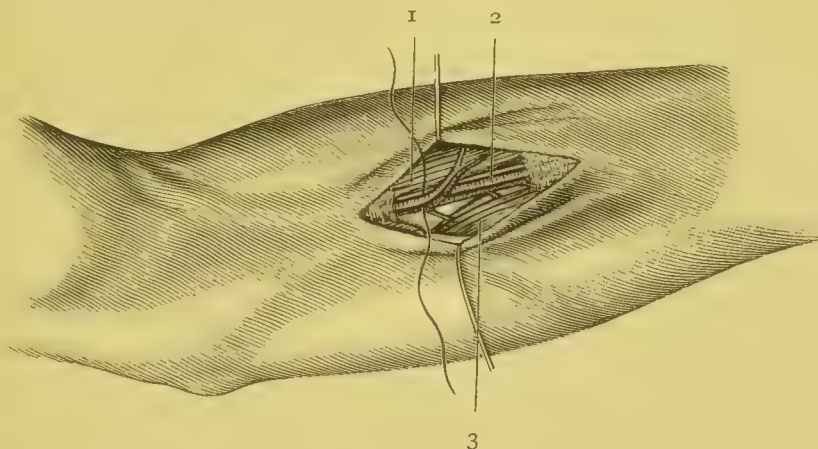
hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least $2\frac{1}{2}$ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pro-

FIG. 26a.



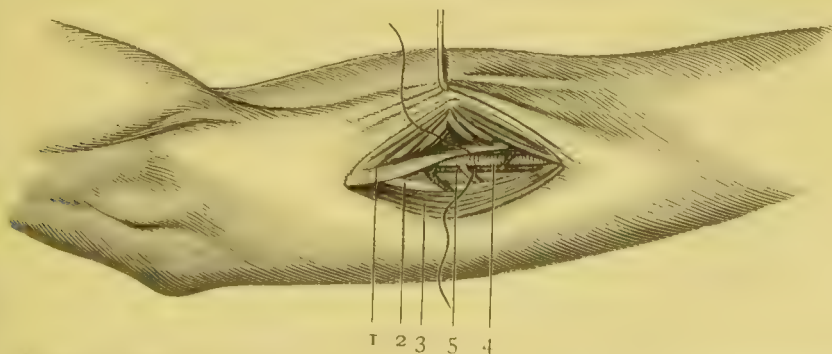
Ligature of radial and ulnar arteries in the lower third of their course. 1. Deep fascia. 2. Radial artery. 3. One of its venæ comites. 4. Tendon of flexor carpi radialis. a, a. Deep fascia cut. b. Flexor carpi ulnaris. c. Ulnar artery. d. One of its venæ comites.

FIG. 26b.



Ligature of radial artery in the upper third of its course. 1. Supinator longus. 2. Radial artery with its venæ comites and the nerve to the outer side. 3. Pronator radii teres.

FIG. 26c.



Ligature of the ulnar artery in the middle of its course. 1. Flexor sublimis drawn outwards. 2. Ulnar nerve (with the vessels) lying on the flexor profundus. 3. Flexor carpi ulnaris. 4. Ulnar artery with (5) one of its venæ comites.

having been opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The *venæ comites* having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM.

(Figs. 25, 26.)

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two-thirds of the vessel will be a line drawn from the tip of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line, and, in the lower third, the outer aspect of the *flexor carpi ulnaris*.

RELATIONS IN FOREARM:—

IN FRONT.

Skin; superficial and deep fasciæ.

Branches of internal cutaneous, ulnar cutaneous nerve, and anterior ulnar vein.

Median nerve.

Pronator radii teres.

Flexor carpi radialis.

Palmaris longus.

Flexor digitorum sublimis.

OUTSIDE.

Flexor digitorum sublimis.
Vein.

INSIDE.

Flexor carpi ulnaris.
Ulnar nerve.
Vein.

Ulnar artery
in forearm.

BEHIND.

Brachialis anticus.

Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 50.

Ligature in the Lower Third of the Forearm (Fig. 25).—Position of hand supinated, to begin with. An incision, 2 inches long, is made, lightly at first, along the outer border of the *flexor carpi ulnaris*, the superficial veins avoided, and the deep fascia, here very thin, opened. The wrist is then flexed, the *flexor carpi ulnaris* drawn gently inwards, the veins separated from the artery, if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third* of the Forearm (Fig. 25).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins being drawn aside or secured with double ligatures, and the wound sponged dry, a white line,† which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here being carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve which lies to the inner side, and which joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it, the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject owing to the depth, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb. 2. Making the incision too short, or too much to the inner or the outer side, and thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor profundus, or that between the flexor sublimis and the palmaris longus.

Aids.

1. Keeping carefully to the above-given line. 2. Hitting off the right intermuscular septum and corresponding sulcus. 3. Finding a muscular branch, and using it as a guide to the artery.

If a wrong space is much opened up in the living subject, the contiguous muscles should be brought together with chromic cat-gut sutures cut short, due drainage being provided.

* The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

† This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

EXCISION OF RADIUS OR ULNA.

Indications.—(1) Sequestra ; (2) Compound fractures ; (3) New growths, especially myeloid. It is only in the last class of cases that any special difficulty will occur, and it is to these, accordingly, that the following account applies.

Operation for Removal of Radius.—This is the bone of the forearm in which myeloid sarcomata usually originate. The following is taken from a most successful case by Mr. H. Morris (*Clin. Soc. Trans.*, vol. x. p. 138), in which he removed the radius and ulna extensively, for a myeloid growth originating in the former, and firmly attaching the ulna to it.

Esmarch's bandage being applied, a long incision was made over the outer side of the radius, from the styloid process to the upper third. The radial nerve was used as a guide to the interval between the supinator longus and extensor carpi radialis longior, Mr. Morris having found on the dead subject that he could most readily separate the soft structures from the front and back of the radius by going between those muscles, and keeping the supinator to the fore part of the incision. The supinator longus and pronator teres at their insertions being detached from the radius, the bone, when freed of its muscles in front and behind, was sawn through at the lower edge of the supinator brevis. A second longitudinal incision of less extent than the first was made along the inner side of the ulna from the wrist-joint upwards, and through it the rest of the soft parts separated from the tumour and ulna. This bone was sawn between 3 and 4 inches above the wrist, and the lower ends of both bones disarticulated by opening the wrist-joint on the inner side. The entire tumour, with the ulna and pronator quadratus, was then removed *en masse*. The anterior interosseous artery was divided just above the pronator quadratus, but no other large branches were injured. The wounds healed in about seven weeks. As soon as a light leather splint was moulded on to the forearm and wrist, the usefulness of the hand steadily increased. Four years later Mr. Morris brought the patient before the Clinical Society (*Trans.*, vol. xiii. p. 155, pl. vi.). There was no recurrence. By the aid of a leather splint, the patient was able to nurse, dress, carry, and wash and care for her children, do her household work, and wash the house linen. She could also stitch and darn, and pick up a pin. Latterly, since contraction had taken place, she could hold her hand out straight without any support.*

Operation for Removal of Ulna.—In the very much rarer cases of myeloid tumours springing from the ulna, the following may be the course adopted. The account is taken from a paper by Mr. Lucas (*Clin. Soc. Trans.*, vol. x. p. 135).

A longitudinal incision, about 4 inches long, exposed the tumour between the flexor and extensor carpi ulnaris. In making this the dorsal branch of the ulnar nerve was divided. The soft parts being next retracted, the bone was exposed above the level of the tumour, and sawn through. The piece connected with the tumour was next drawn out of the wound, while the interosseous membrane was divided, and the extensor indicis on the posterior and the pronator quadratus on

* After these operations, as in any in which the flexors and extensors of the fingers must, of necessity, be meddled with, passive movement of the fingers should be commenced very early and energetically persevered with.

the anterior separated from the tumour. The removal was completed by dividing the ligaments of the lower radio-ulnar joint, the attachment of the triangular fibro-cartilage to the ulna and the internal lateral ligament. The patient left the hospital in five weeks, the resulting usefulness being excellent.

Excision of Radius and Ulna in Military Surgery.

—By this is meant deliberate removal of portions of these bones damaged by gunshot or other injuries, not the mere picking away of spicula and fragments.

Dr. Otis* divides the cases into the three groups of primary, intermediary (before the thirtieth day), and secondary (after the thirtieth day). Though caries and attempt at repair were met with in these latter cases, there was no time for invagination of sequestra. Thus they were very different from necrosis operations, and hence, in great measure, the high mortality. Of the primary 10 per cent., of the intermediary 19 per cent., ended fatally; the mortality of the secondary was nearly as high as that of the primary excisions.

The concluding observations of Dr. Otis are worthy of the most careful attention of military and naval surgeons:

"Of this large number of excisions in the continuity of the forearm there is little to remark save that, in the aggregate, the mortality of shot fractures of the bones of the forearm appears to have been sensibly augmented by operative interference, and that I have sought in vain for a single instance in which a formal excision of a portion of the shaft of either radius or ulna had a really satisfactory result as regards the functional utility of the limb. The representations of Baudens of his Algerian experience led the German surgeons to practise these excisions in the shafts of long bones to some extent in the Danish and Austrian campaigns with very unsatisfactory results. Similar operations were resorted to with comparative frequency during the American War, and the results plainly indicate, I think, that formal primary operations of this nature should be banished from the practice of military surgery. It is bad enough to remove adherent primary sequestra, for our museum abounds in examples where such fragments have retained their vitality, and maintained the continuity of long bones; it is worse to deliberately remove unoffending healthy portions of the bone. The mortality, greatly exceeding that of the expectant conservative treatment, the numerous consecutive amputations, and the large proportion of hopelessly deformed limbs sufficiently condemn such operations. I have found nothing in the reports of the surgery of the late Franco-German War that was not conformable to these conclusions."

Sir T. Longmore (*System of Surgery*, vol. i. p. 544) brings the following striking experience to bear on these cases:

"I have seen many of these fractures in which primary resection of a portion of the entire shaft by a shot has occurred, and have not met with bony union in any case where the gap was a full inch in amount."

Causes of these Resections doing Ill or Failing.

- | | |
|----------------------------------|---|
| 1. Osteo-myelitis. | 6. Non-union. False joint. |
| 2. Pyæmia. | Flail-like limb. |
| 3. Hætic. | 7. Displacement of the hand at the wrist. |
| 4. Hæmorrhage. | 8. Permanent contraction of flexor or extensor tendons. |
| 5. Painful irritable cicatrices. | |

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 935 *et seq.*

AMPUTATION OF FOREARM (Figs. 27, 28, 29, 30).

Practical Anatomical Points.—In this frequently performed operation the following should be kept in view :

(a) The two bones are not fixed, like those in the leg, but movable. This mobility may prevent their being parallel when the knife is sent across in transfixion, and thus lead to penetration of the interosseous membrane: it must also be remembered in sawing the bones. Lastly, on this mobility in pronation and supination depends the usefulness of the stump, which must therefore be left as long as possible, the bones being always, when practicable, sawn well below the insertion of the pronator radii teres into the middle of the outer surface of the radius. If the bones be divided above the insertion of the pronator teres, the radius will become supinated and further rotation movements will be lost.

(β) In the upper part of the forearm, both in front and behind, are fleshy bellies; below, the soft parts are increasingly tendinous. Furthermore, the anterior border of the radius and the posterior of the ulna, especially the latter, are largely subcutaneous.

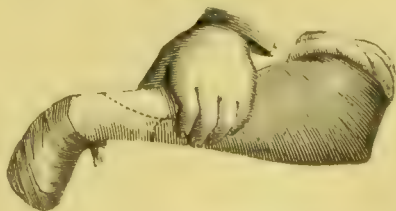
Different Methods.

- | | |
|--|-----------------------|
| 1. Skin flaps, antero-posterior or lateral, with circular division of muscles, &c. | 2. Transfixion flaps. |
| | 3. Circular. |
| | 4. Teale's. |

1. Amputation of Forearm by Skin Flaps, with Circular Division of Muscles, &c. (Figs. 27, 28, 29).—While, in an amputation so often called for, it is well to practise several methods, none, on the whole, answers so well as this, for the following reasons: (a) By cutting one flap a little longer than the other, sufficient skin can always be obtained to give a good stump. (β) Transfixion, while quite unsuited to the lower third, owing to the numerous tendons, can only be performed in the upper third in moderately muscular forearms with ultimate satisfaction. For in a bulky, fleshy limb (as in a case of accident in a male adult) it is not easy always to cut the skin longer than the muscles in bringing out the knife, and so to prevent the tendency of the fleshy bellies to protrude while the flaps are being united; and a little later, these muscles, with large surfaces cut obliquely, give rise to a good deal of blood-stained oozing, which is very likely to cause tension, suppuration, and delay in healing.

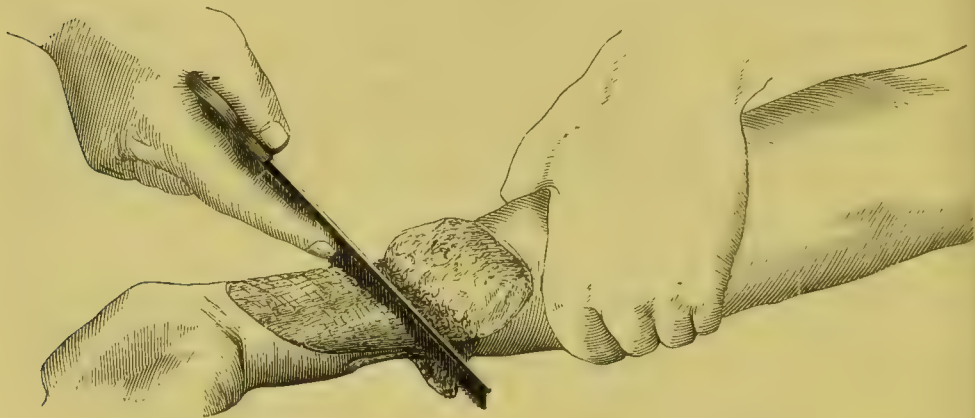
The brachial being secured with an Esmarch's bandage, the arm extended from the side, with the forearm pronated and the hand steadied by an assistant, the surgeon standing outside the limb on the right, and inside it in the case of the left side, places his left index and thumb on the borders of the radius and ulna, at the spot where he intends

FIG. 27.



to saw the bones (Fig. 27). The point of a narrow-bladed knife (about 4 inches long), or a small catlin, is then inserted just below the index, carried along the bone for 3 inches, then curved suddenly across, so as to mark out a broadly arched, not a pointed,

FIG. 28.



flap (Fig. 28), and finally carried up along the bone nearest to the surgeon to a point just below the thumb.

This flap is then dissected up without scoring, consisting of skin and fasciæ.* The forearm is next raised by the assistant holding the hand, so that its palmar aspect faces the surgeon,† who marks out, by a curved cut joining the two horns of the other incision, a similar flap on the anterior surface, but one only about 2 inches in length. This flap being raised and both retracted, the soft parts are divided with a circular sweep close to the base of the flaps, this being repeated once or twice till the bones are quite exposed. The knife is then passed, with due care of the severed arteries, between the bones, so as to divide the interosseous membrane, and the periosteum next cut circularly where the saw is to pass. The bones are then sawn through, with the following precautions:—The heel being placed on the bones, it is drawn lightly, but firmly, towards the operator two or three times, so as to make a groove. With a series of light sweeps, in which the whole length of the saw is used, the two bones are then cut through together,‡ the limb being kept supinated during the use of the saw, so as to keep the bones as parallel as possible.

* The under surface of a so-called skin flap should always, when possible, show a few muscular fibres; this shows that the deep fascia is present, in which the vessels run down to send up branches to supply the skin.

† Care must be taken to keep the bones parallel, now, and throughout the operation.

‡ Some advise that the more movable radius should be divided before the section of the ulna is completed. If the saw is used lightly and swiftly, both bones will be sawn simultaneously. The student usually commits these faults in the use of the saw—he bears too heavily on it, thus locking it or fracturing the bone, and he makes but short sweeps, using half of the instrument only.

The assistant in charge of the lower part of the limb must be most careful to hold it steady: if he depress at all, the bones will certainly splinter when half sawn through; if, on the other hand, he raise the parts, the saw will be locked.

Any tendons requiring it are then trimmed, nerves cut short and square, and the vessels ligatured or twisted. These are usually four—viz., the radial, under cover of the supinator longus, close to its bone; the ulnar, covered by the flexor carpi ulnaris, on the front of the ulna. Their respective nerves are good guides to the arteries, save quite low down, when the radial has gone to the back of the limb. The anterior interosseous is found on the front

FIG. 29.



(Farabeuf.)

of the interosseous membrane, and the posterior interosseous between the deep and superficial extensors.

If the surgeon prefer it, instead of having the forearm raised so as to face him (Fig. 29) while he shapes the flap from the anterior or flexor surface, he will tell the assistant to completely supinate the forearm, and proceed to make the flap with the limb in this position.

If, owing to the condition of the soft parts, lateral flaps are preferred, the limb being pronated, the surgeon marks the site of bone-section with his left forefinger and thumb placed on the

centre of the extensor and flexor aspects of the limb at this level. Then, looking over the forearm, he enters his knife in the middle of the flexor surface, and carries it, cutting a broadly arched flap, about $2\frac{1}{2}$ inches long, to a corresponding point on the centre of the back of the limb, and then from this point down again over the side nearest to him, to the spot where the knife was first entered. The flaps are next dissected up with the precautions already given, and the operation completed as before.

2. Amputation of Forearm by Transfixion Flaps (Fig. 30).

—In the case of a moderately muscular forearm the surgeon may make use of this method in amputating through the middle of the forearm. For reasons already given (p. 57), this method is not recommended, but the rapidity with which it can be done com-

mends it to the notice of those who may have to treat wounded in war on a large scale, or railway accidents where more than one limb requires amputation. The limb being abducted, and the forearm supported and pronated, with the bones as parallel as possible, the surgeon, standing outside the right and inside the left limb, lifts up the soft parts* at the spot where he intends to saw the bones, and sends a narrow-bladed knife (4 to 5 inches long) across the limb, entering it and bringing it out just above the bones. He then, by cutting downwards and

FIG. 30.



(Fergusson.)

forwards, shapes as broad a flap as possible with a steady sawing movement, taking care, before bringing out the knife, to cut the skin longer than the muscles by continuing the use of the knife after the latter are felt to be cut through. The flap should be 3 to 4 inches long according to the condition of the tissues on the other side, each flap being made as broad as possible and bluntly rounded as it is finished.

The tissues on the front are then lifted from the bones and transfixed by passing the knife across immediately above the bones at the base of the first-made flap, the limb being now supinated. As in this second transfixion the skin on the farther side of the limb may be punctured, it is well for the surgeon to hold down its cut edge with a finger. The second flap is then cut, broad, well-rounded, and $2\frac{1}{2}$ to 3 inches long according to the

* This step is most useful—in fact, essential. It is often forgotten.

length of the anterior. In making either flap, while the muscles are being severed, the wrist should be kept flexed. The flaps are then retracted, the soft parts severed with a circular sweep, the interosseous membrane divided, and the rest of the operation completed as in the method first described (p. 58). If this method is used the nerves should always be cut short and square; otherwise painful bulbous ends may follow.

A very rapid and effective modification of the above is the following: As, owing to the inequality of the soft parts on the back as compared with those on the front of the forearm, and also from the proximity of the ulna to the surface here, transfixion of a dorsal flap is not always easy, a quicker method is as follows. A skin flap, $3\frac{1}{2}$ inches long, broad and well rounded, being marked out on the posterior aspect of the limb, the knife is immediately, without being taken off, pushed across in front of the bones and made to cut a flap, by transfixion, $2\frac{1}{2}$ inches long, the skin being cut longer than the muscles (p. 57). The dorsal skin flap is then dissected up, the flaps retracted, and the bones cleared as before.

3. Amputation of the Forearm by the Circular Method.—

This method is not recommended here owing to the flat shape of the limb and the adhesion of the deep fascia above to the muscles. It is best suited to amputation in the lower third. It may be performed as follows: The surgeon, standing outside the limb, which is kept supinated, having drawn the skin well upwards, passes a knife under the forearm, then above, and so around it till, by dropping the point vertically, the back of the knife looks towards him, and its heel is resting on the part of the forearm which is nearest to him. An incision is then made circularly through skin, superficial and deep fasciæ,* round the whole circumference of the limb $2\frac{1}{2}$ inches below the point where the bones are to be sawn. The completion of this circular sweep is aided by the assistant in charge of the limb rotating it so as to make the tissues meet the knife. The forearm is supinated at first, but may be flexed later, while the cuff is being dissected from the posterior surface (Fig. 29).

A circular, cuff-like flap of tissues having been turned back as high as the point of bone-section, a second and much firmer circular sweep is here made through everything down to the bones, this being repeated till all the soft parts are cut clean and square. If there is any doubt about the sufficiency of coverings to the bones, the soft parts around these may be freed a little higher (care being taken not to prick the radial or ulnar); the soft parts are then vigorously and firmly retracted, and the bones sawn through with the precautions given at p. 58.

* If, in raising the cuff-like flap, muscular fibres are seen on the under surface, the presence of the deep fascia and, thus, a better blood-supply will be assured than by the quicker method of simply peeling the skin and subcutaneous tissue off the deep fascia.

CHAPTER IV.

OPERATIONS IN THE NEIGHBOURHOOD OF THE ELBOW-JOINT.

AMPUTATION AT ELBOW-JOINT (Fig. 31).

THIS operation gives excellent results, good flaps being obtainable from the thick soft parts in front, and from the skin behind which is well used to pressure. Furthermore, there are no bones to saw.

It has not been performed as often as it might have been, owing, perhaps, to the belief which some surgeons have held that cartilaginous surfaces left in a wound are a source of delay in healing, an opinion no longer of importance in antiseptic surgery; from the fact that any disarticulation, however simple, is considered to complicate an amputation; and because, owing to the expanded end of the humerus, the flaps required are somewhat larger than in amputation through the lower third of the humerus.

Practical Points.

(a) The internal condyle is nearly $\frac{1}{2}$ inch below the level of the external.

(β) The joint is opened most easily on the outer side.

(γ) There are masses of muscles on the front and sides; of the latter, those on the outer side (owing to the presence of the supinator longus) retract more powerfully than those on the inner.

(δ) The skin on the back of the joint is well used to pressure, and is connected by fibrous bands to the back of the ulna.

Methods.—Owing to the vascularity of the parts, any of the following may be made use of. I would advise the student to practise the first especially.

- i. Long anterior flap with short posterior (Fig. 31).
- ii. Lateral skin flaps, or a single lateral flap.

iii. Circular.

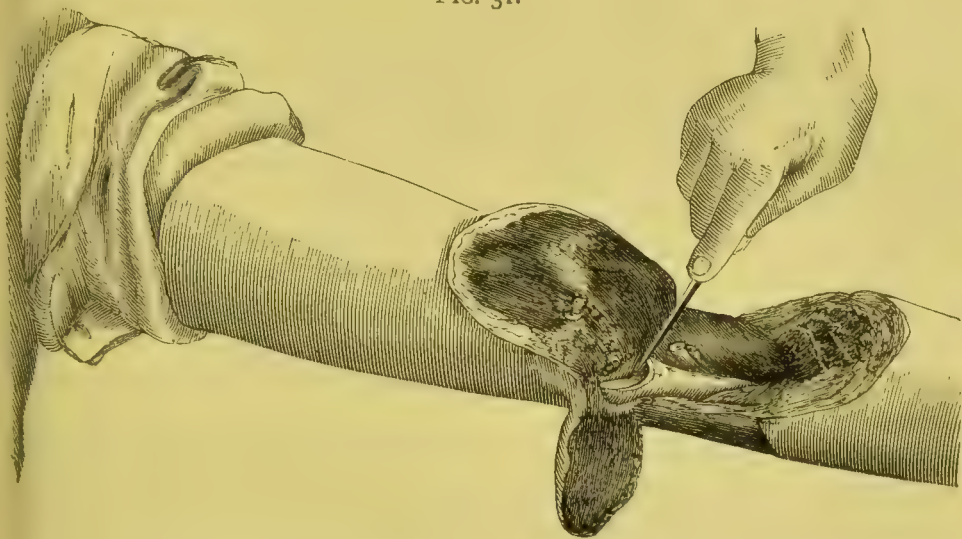
iv. Long posterior flap.

v. Long anterior flap.

i. **Long Anterior Flap** (usually by Transfixion), with **Short Posterior Flap** (Fig. 31).—This method gives an excellent covering to the front of the humerus, allows of easy drainage, and preserves skin which is well used to pressure.

The brachial being controlled a little above its centre,* the forearm being held somewhat flexed and completely supinated, the surgeon, standing on the inner side in the case of the left, and outside the right limb, raises the soft parts in front of the elbow triangle, and sends his knife, held horizontally, across, just in front of the joint. Thus, entering it an inch below the internal condyle, and bringing it out $1\frac{1}{2}$ inch below the external one, or *vice versa*, he cuts a well-rounded flap, 3 inches long, taking care, as the knife emerges, that the skin is cut longer than the muscles. Then, passing his knife behind the limb, and looking over, the

FIG. 31.



Amputation through the elbow-joint by anterior and posterior flaps, at the moment of disarticulation.

surgeon joins the two ends of the base of his first incision by a convex cut through the skin over the back of the olecranon, so as to mark out a flap $1\frac{1}{2}$ inch long. This is raised without scoring, care being taken to keep the knife towards the ulna, for fear of "button-holes." The two flaps being then held back, any remaining structures in front are severed, the joint first opened on the outer side, and the forearm removed by dividing the lateral ligaments and triceps.†

During the last steps the assistant in charge of the forearm pulls this away from the arm.

The brachial artery is next secured, together with any other vessels which continue to bleed on removal of the Esmarch's

* The assistant who has charge of the Esmarch's bandage, and who is steady-
ing the arm, should draw the skin on the back of the elbow-joint somewhat
upwards.

† In Fig. 31, by mistake, the operator has been shown commencing disarticula-
tion on the inner instead of on the outer side, which is usually the easier. The
flaps also are rather too long. For these errors I alone am responsible.

bandage. Any nerves which require it are then cut short, a drainage-tube inserted, and the flaps carefully united.

Modifications of the Above.—The flaps can be cut of different lengths, according to the state of the soft parts. If the surgeon prefer to do so, he can cut his anterior flap from without inwards instead of by transfixion, a course which may well be adopted in an unusually bulky, muscular limb. The posterior flap can be made by cutting from within outwards, after disarticulation, but this, while quicker, is usually less preferable.

ii. **Amputation by Lateral Skin Flaps, or by one Lateral Flap.**—The advantages of this method are, that it is very easily done, and that, if more skin is available on one side than on the other, flaps unequal in length can readily be made. If the surgeon amputate by equal lateral flaps—standing as before, and having his left index finger on the centre of the elbow triangle and left thumb at the corresponding point behind, he looks over, and enters his knife close to his thumb, and marks out, on the side farthest from him, a flap well rounded, and about $2\frac{1}{2}$ or 3 inches long, reaching to the finger in front. He then marks out a corresponding flap from this point, on the side nearest to him, to that where he began. These flaps are then dissected up of skin and fasciæ as thick as possible, the soft parts severed with a circular sweep, and disarticulation performed, beginning at the outer side.

iii. **Circular Method.**—The surgeon, standing as before, makes a circular incision round the forearm, $2\frac{1}{2}$ or 3 inches below the joint, going through skin and fasciæ. A cuff of skin is then turned back as far up as the joint, the muscles severed with one or two firm sweeps, the lateral ligaments divided, and disarticulation performed as before. The edges of the wound may be united either horizontally, or vertically from above downwards.

EXCISION OF ELBOW (Figs. 32, 33, 34, 35).

Practical Points.—These bear upon the success of this operation.

(1) It is a comparatively simple joint, with small articular surfaces readily got at. (2) Its synovial membrane is simple. (3) Its vascular supply is abundant. (4) The surrounding muscles are powerful, ensuring, if they regain firm attachment, excellent mobility. From the above, and from the untoward effects of ankylosis, a natural cure in the elbow is, often, not so useful as that given by excision. This operation should be performed oftener, especially in the first six of the following conditions:

Indications.

(1) Pulpary disease. Where this has resisted treatment in a patient who shows no sign of tuberculosis, lardaceous disease, &c., where it is the only large joint affected, and where the powers of

repair are sufficient. If treatment fails to promise a movable joint, there is no good losing more time; the muscles will only be more wasted, sinuses will only form more extensively, and the patient's health be more impaired.

2. Injury and its results. (A) *Primary excision*. When the joint is much opened, the cartilages much damaged, when the shaft is intact and the tissues in front are sound, an excision may be preferable to expectant treatment. If aseptic from the first the operation excludes the risk of acute arthritis, and its certain sequela a stiff joint. But here, as in excision for disease, the determination and pluck of the patient will be most important factors. (B) *Secondary excision*.

When acute arthritis, not yielding to incision and drainage of the joint, has followed on an injury, and ankylosis is the best result which can be hoped for without operation. In such cases, as the inflamed condition of the bones and soft parts may produce septic cellulitis and osteo-myelitis after an operation, it will be wiser, before excising, to wait till the inflammation has somewhat subsided. It must be remembered that, in excision after injury, reaction will probably be greater, suppuration more certain, and a tendency to bony ankylosis more marked, especially if the periosteum is preserved. Sufficient drainage is absolutely needful.

3. Old injuries to elbow-joint, resulting in stiffness, ankylosis, or, more rarely, to pressure on the main vessel or nerve trunks. I hope the following may be useful to my younger readers when the question arises in such cases, whether we should interfere and, if so, how far should we go.

i. Operative interference is justified in cases where the patient is otherwise healthy, and where his future will be seriously crippled.

ii. As to the nature of that interference.

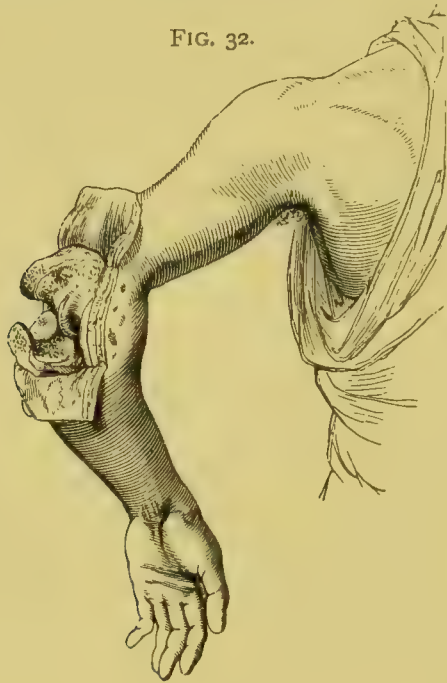
(A) *Forcible movement under an anæsthetic*. This, often resulting in the "infracion" of some American surgeons, is not to be recommended. The results are rarely good, may be *nil*, and may be followed by serious damage (Wight, *Ann. of Surg.*, Aug. 1893).

(B) *Arthrotomy*. Opening the joint, division of adhesions, attempted reduction of displaced bones with the fingers or a blunt hook, will be found a step of very limited usefulness. *Partial excision*.

This course has been recommended by several American surgeons. Thus, Dr. Wight, of Brooklyn (*loc. supra cit.*), gives four cases of stiff elbow after fracture, in which he removed the lower end of the humerus by an incision made over this bone and the head of the radius. The results would appear to have been satisfactory, but the exact degree of success is not stated. I am of opinion that those same conditions, which, after an injury to the elbow-joint, may interfere with any good result from forcible movement, will also interfere with success after partial excision. I refer to development of osteoid masses in stripped up periosteum, displacement of part of the torn capsule between the joint surfaces, filling up of the articular cavities with fibrous tissue, deformities at one or more points in the joint owing to overgrowth of the epiphysial line, and lastly, perhaps, ankylosis between the radius

and ulna. Some of the above, *e.g.*, the formation of osteoid deposits, will be especially marked in young subjects. Here, owing to their marked reparative power, and the inflammation set up by the injury, the tendency to secondary ankylosis is so great that it will best be met by a free removal of the bony surfaces. Partial excision risks a result of incomplete value—*i.e.*, a joint of limited movement, though at a useful angle. iii. Of the importance of a wise employment of passive movement I have spoken at p. 72. The following

FIG. 32.



Excision of the elbow by the H-shaped incision. The thickened soft parts, the sinuses, the carious ends of the bones, together with the position of the ulnar nerve, are admirably shown. (Fergusson.) The above incision, while giving more free exposure, and rendering the operation easier, has the serious disadvantage of damaging the triceps, and of leaving additional scars, which may hamper the movement of the new joint.

is, very briefly, an interesting case of excision of the elbow for an old dislocation and fracture:

M.E. W., aged 28, was sent to me in February 1894 by Dr. E. Davies, of Swansea. The injury, received the previous November while he was riding over a sheep farm in Terra del Fuego, had never been treated. A dislocation backwards of both bones of the right elbow-joint was typically evident, and in addition there was distinct shortening of the humerus, marked coldness and lividity of the hand, and deficient radial pulse. The limb was fixed in the extended position, active and passive movements being almost completely abolished. During the excision it was found that a fracture ran obliquely from without inwards through the lower third of the humerus. When the limb was placed in the extended position after the operation, there was still a full $1\frac{1}{4}$ inches between the bone-ends. Healing was uneventful. At the end of four months the patient, a man of undaunted pluck and imperturbable temper, could use the arm to play lawn-tennis, shoot rabbits, and ride. When I last saw him, five months after the operation, extension and prona-

tion were practically complete, flexion was full enough to allow of his touching his right ear and buttoning his collar stud with the right hand, but not sufficiently perfect for him to touch his right shoulder. Only about half the full range of supination was present. A year later the patient wrote saying: "My arm is as useful to me as it was before the accident. I can shear sheep, ride, and shoot with any man."

4. Ankylosis in a faulty position. When this, as the result of injury or disease, whether bony or densely fibrous, renders the limb useless. In deciding whether to excise for ankylosis, the surgeon should make out how far the limb is really useless, whether there are any cicatricial bands, especially in front, and whether the wasting of the muscles is very marked, for these may be so long and so utterly atrophied that the limb may be but little more useful after operation. 5. Disorganising arthritis of elbow after pyæmia or rheumatic fever. 6. Osteo-arthritis. If the patient is healthy, not advanced in years—*i.e.*, not much over forty, and not broken down—and if this is the only joint attacked. The surgeon must be prepared for sawing very dense bones here. 7. For growths of the bones, especially if innocent and affecting one bone—*e.g.*, exostosis.

The following points call for consideration in any case where excision of the elbow is being discussed:

1. *Age*.—This must always have much influence. In very young children due attention must be paid to the naturally great power of repair. After thirty-five or forty the surgeon should weigh very carefully all the points of the case, and only excise where all else is favourable. From puberty* to thirty-five I consider the best age.

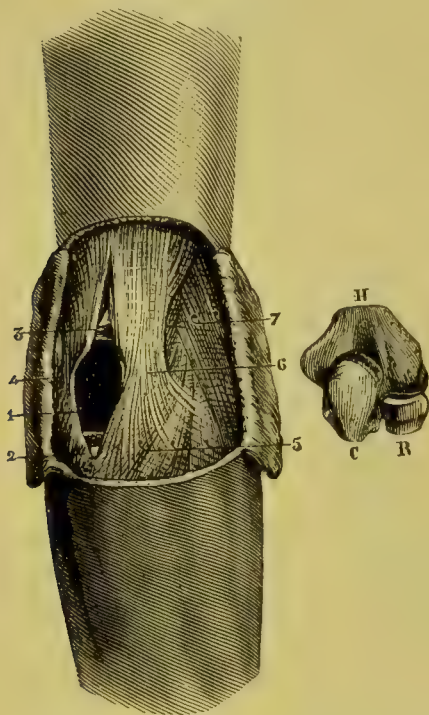
2. *Complications*.—These are most likely to present themselves in the shape of diseases of other bones and joints, for such a complication as phthisis calls for amputation. Caries of the metacarpal or metatarsal bones is not of itself a contra-indication. If a diseased spine is present, the question of excision will depend on whether the vertebral caries is old, or recent and active. If old, is the elbow a source of much irritation? Two large joints are rarely diseased at the same time. Mr. Holmes (*Clin. Soc. Trans.*, vol. i. p. 143) records a case of a boy aged five where he excised, with excellent result, both elbow-joints, only a few weeks intervening between the two operations.

Mr. Clement Lucas (*Brit. Med. Journ.*, 1881, vol. ii. p. 897) relates a case in which disease of the left elbow came on about two years after excision of the right joint, and was also successfully operated on. Since 1886 I have excised the elbow-joint with good result in four children, in whom some years before I had successfully excised a knee-joint.

* As is stated below (p. 72), young children are not satisfactory subjects for after-treatment and movement. Mr. Annandale (*Lancet*, 1879, vol. i. p. 256) has excised successfully in patients aged three and seventy-five. No details are, however, given.

3. *Question of the Value of Preserving the Periosteum.*—While the periosteum may be easily preserved in cases where it is swollen and loose, its preservation is in others a matter of very great difficulty, rendering the operation much more laborious and prolonged, and * it is extremely doubtful if its advantages are

FIG. 33.



Right elbow after excision of the joint by the usual posterior incision. (Farabeuf.) 1 and 4. Cut edges of the outer expansion of the triceps tendon. 2. Ulna. 3. Humerus. 5. Anconeus, covered by 6. Outer expansion of triceps. 7. Supinator longus and radial extensors of the carpus. To the right the bones removed during the operation are seen. The humerus has been sawn through at a point somewhat higher than usual.

the shoulder of the affected side, and the limb flexed and carried over the front of the trunk so as to present it fairly to the surgeon, who usually stands on the opposite side of the body.

The surgeon, then, noting the relative position of the condyles

equivalent in this joint, where the ordinary operation gives such excellent results. Some cases—*e.g.*, primary excision for injury—are unsuited to this method, as the periosteum is unaltered. In strumous disease it is often unsuitable, on account of the risk of leaving pulpy mischief behind.

Sub-periosteal resection is said to lead to less hæmorrhage, less disturbance of the capsule and attachments of muscles, and greater completeness of the new joint. While the last of these is undoubted, it may bring about impaired movement,† and I am of opinion that the surgeon should only trouble to preserve the periosteum in cases where an unusually large amount of bone has to be removed. If the periosteum is kept, passive movement will be additionally needed.

Operation.—The single vertical incision at the back gives such excellent results that this only will be fully described. Esmarch's bandage having been applied at mid-arm, or the whole limb being rendered evascular as far as the above point by the use of two bandages, a pillow is placed under

* In the case of excision of the shoulder-joint (p. 142), the conditions are very different.

† A case is given (Langenbeck, *Arch.*, vol. viii. p. 136) in which, after sub-periosteal resection, the condyles had been very perfectly reproduced, and the olecranon had been re-formed to even an inconvenient extent, for it was so long and curved as somewhat to limit extension. This method should usually be rejected in children, and also in cases of ankylosis, for fear of a recurrence.

and the course of the ulnar nerve, makes a straight incision of sufficient length* (3 to 4 inches in the adult), with its centre at the tip of the olecranon, a little internal to the centre of the back of the joint, and parallel with the ulnar nerve. This incision should begin above or below as is most convenient, and go down to the bone throughout its whole extent, splitting the triceps muscle and tendon. Partly with the point of the knife, partly with an elevator or blunt dissector† (Fig. 36), the surgeon then raises, as far as possible in one piece and without tearing or jag-

FIG. 34.



To show the level to which the bones are to be cleared, and the way in which the thumb-nail is kept between the knife and the soft parts.

ging, the outer half of the triceps, which, with its expansion into the deep fascia of the forearm over the anconeus (this latter muscle being taken up at the same time), is peeled up as thickly as possible from its insertion into the ulna.

I may here say that the French resection-knives and elevators (Fig. 36) are far superior to our own. A glance at Fig. 36 will show this to any one who is familiar with the difficulties of an excision on a powerful adult for an injury, or after ankylosis.

The deeper parts on the outer‡ side of the joint are then separated from the bones with the point of the knife and thumb-nail or blunt dissector, until the external condyle and head of the

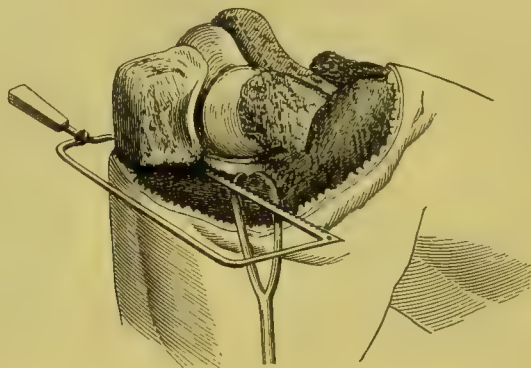
* An insufficient incision will only increase the difficulty of the operation, and by the bruising then consequent upon the strenuous use of retractors, lead to suppuration.

† The more readily the periosteum and soft parts separate, the more will the blunt instruments be used. As a rule, the use of the knife (Fig. 36) is called for. The cuts should each be short, and as each is made the edge must ever be kept turned towards the bone.

‡ For the sake of practice, it is well to take the outer side first, before clearing the inner, with the ulnar nerve in proximity to it.

radius are completely exposed. The left thumb, all the time sunk deeply into the wound, pushes the flap of soft parts as it is detached, towards and over the external condyle. It is, finally, displaced over this, as the joint is flexed strongly. Next, the parts on the inner side should be detached from the inner condyle and inner border of the olecranon, great care being taken, by the following precautions, to keep intact the ulnar nerve:—(a) By keeping the knife parallel with the nerve and close to the bone; (b) By the use of the thumb-nail, which peels off the soft parts before the knife. By these means the soft parts will be satisfactorily cleared from the bones; retractors (Fig. 36), well applied, will be found most useful, as the process of peeling off the soft parts is somewhat fatiguing to the thumb. This is especially the case in excision for accidents or on the dead body, and it is in these only that the nerve may be seen, though indistinctly.

FIG. 35.



To show the application of the saw. The dotted line across the humerus shows that the saw should pass well above the articular cartilage.

Where the parts have been long inflamed, they peel off much more readily, and the nerve is buried in the swelling.

Each lateral ligament, if this has not been already done, is raised, together with the periosteum and the group of flexors or extensors respectively, and freed from and pushed over the condyles and so kept with retractors.

The joint is now strongly flexed, and the capsule opened just above the olecranon; the bone-ends are then turned out and prepared for the saw by passing the knife down to the bone, along the lines of intended section, the soft parts being well retracted beyond these lines.

SITE OF BONE SECTION.*—The ulna should be sawn (towards the joint with a small Butcher's saw set firmly) so as to remove the greater and lesser sigmoid cavities with the olecranon. The radius is removed at the same time just below its head, above the biceps. Before this is done, the assistant who is holding the forearm

* See the remarks below on the amount of bone to be removed (p. 72).

should thrust the ends of the bones prominently into the wound. The section of the humerus should be through the base of the condyles, so as to remove all the articular cartilage. While the bones are sawn, the olecranon and trochlea of the humerus may be steadied in the grip of a lion-forceps held vertically, the soft parts at the sides being well retracted. Any soft, caseous patches in the bone-ends are now gouged, any possible sequestra removed. In bad cases the bones are liable to be fatty, with little natural marrow; such, however, are not necessarily irrecoverable. If the bone above the levels of section appears roughened, and the site of periostitis, this need not be touched; all will probably subside when the cause of irritation is removed. Any sinuses should next be laid open, with due regard to the ulnar nerve, and their contents scraped out with sharp spoons. A zinc chloride solution (gr. x— $\bar{3}$ j) may be applied cautiously if there is any doubt about the parts being aseptic; but any solution stronger than this runs the risk of causing sloughing where the vitality of parts is low. One or two points of suture may, perhaps, be inserted, so as to close just the ends of the wound; but all the rest of this should be left open, and a drainage-tube inserted. If the parts are softened by inflammation, blistering, &c., or if it is a case of extensive disease, sutures had better not be used.* Very varied forms of splint have been advised.† Some surgeons, to keep the bones apart, from the first put the limb up on some form of right-angled splint; others, fearing a flail-like condition of the joint, prefer to begin with the arm and forearm on a straight splint, or on one with an obtuse angle (about 135° —Ashurst, *Encyclopædia of Surgery*, vol. iv. p. 477). As ankylosis is, in children especially, to be dreaded (*vide infra*), I prefer to put cases up from the first on a right-angled splint, using some such cheap form as that which I have described in the *British Medical Journal*, 1877, vol. i. p. 774, in which the anterior metal bar supports the limb, while it leaves the wound exposed and is easily kept clean, the movable hand-piece readily admitting of early passive pronation and supination.‡

Passive movement of the fingers and wrist should be begun on the second or third day. The joint itself should be moved as soon

* Farabeuf (*Man. Opér.*, p. 710) points out that if, owing to long-existing disease of the elbow, the shoulder, wrist, or fingers are stiff, opportunity should now be taken to break down adhesions.

† By some surgeons a splint is here dispensed with. I strongly advise the use of one which is light and simple (*vide supra*), especially in children, as during the first two weeks, where a splint has been dispensed with, the bone-ends have been known to project from the wound.

‡ Mr. Heath's and Mr. Mason's splints are intended to aid in restoring the movements of the joint, while they also separate the ends of the bones. Prof. Esmarch's double-bracketed splint, Prof. Butcher's box-splint, and Prof. Volkmann's wire splint (based on that for the lower extremity of Prof. Nathan Smith) have all been highly spoken of in military surgery.

but very gently, and slightly, as all irritation has entirely subsided and the deeper part of the wound is firmly healed (about the 18th to the 21st day), this date varying according to the size of the gap left between the sawn bones, the probable condition of the tissues as to inflammatory exudation, &c. In children an anæsthetic may have to be given several times. The angle of the splint should be altered or the limb put up straight for a few days, and then flexed. Later on, weight-extension should be used, by securing a bag of shot, which is added to from day to day. Later, the sound limb may be fastened up, so that the child must use the excised joint. This getting children to use the joint is often most difficult, as friends are usually too foolish to see that the surgeon's directions are carried out daily, because they cause a little short, but most necessary, suffering. Parents are far too ready to think that because an operation has been performed, and the wound nearly, if not quite, healed, no more is necessary.* In commencing pronation and supination early, the ulna should be steadied while the hand and radius are very carefully moved. The first attempts at passive movement should be exceedingly gentle, and too much should not be attempted at first. I am aware that the date above given for the commencement of passive movement is later than that often taught—*e.g.*, about the tenth day. Nothing will be lost, but much gained by giving the parts the longer rest. If the surgeon pictures to himself what is going on under the skin he will recognise that every time early passive movements are practised, the uniting structures, as yet richly cellular with vessels of embryonic tissue, are injured, fresh exudation and hæmorrhage follows which must all be absorbed or organised. When the parts are sufficiently firm, the splint may be left off and a sling substituted. Falls must be carefully avoided, and no liberties taken with the new union—*i.e.*, by a patient attempting to do too much with the limb, as in lifting.

AMOUNT OF BONE TO BE REMOVED. (Figs. 33, 35.)—This should be, roughly speaking, all the articular cartilages,† including about $1\frac{1}{2}$ inch from the humerus, and the same from the ulna, the radius being sawn through just below its articular head. In cases of ankylosis,‡ most bone must be removed from the humerus, that from the bones of the forearm being limited by attachment of important muscles. Mr. Annandale (*loc. supra cit.*) considers that an interval of $1\frac{1}{2}$ inch should intervene between the bones after the sawn sections have been made, and the bones placed in the

* Pronation and supination in a child are often only apparent, the forearm and arm being rotated together from the shoulder.

† The greater breadth and depth of the trochlear surface on the back than on the front of the humerus must be remembered.

‡ In cases of bony ankylosis, it is best, before attempting to make sections of the bones, either to break down the union forcibly (care being taken not to fracture the possibly atrophied bones above and below), or, better, to divide the bony ankylosis with an osteotome or saw.

position of extension. Certainly, no locking whatever should take place when the forearm is completely flexed and extended.*

Mr. Holmes has pointed out long ago that if, after removing as much bone as is wise, disease is still felt on the anterior surface—*e.g.*, of the ulna—it is not necessary to make further sections in order to get beyond it; scraping will be sufficient, and save any further interference with attachment of muscles.

TEST OF SUCCESS.—The movements should so increase after the first six or eight weeks that within about four months from the operation the patient should be able to move the new joint almost as well as the other, to dress and feed himself, and to lift weights of good size.

REPEATED EXCISION.—I have tried this in two cases—instances of obstinate pulpy disease—in each a very useful but much shortened limb resulted. While opening up the old wound and again separating the bone ends gives excellent access to the remaining disease, this step will be but seldom required if the rule is followed, after excision of such joints, to give ether repeatedly as soon as there is evidence of persistent disease, and slit up any sinuses or undermined tissues, thoroughly use sharp spoons, and, if needful, pack in for a few hours strips of iodoform gauze wrung out of an emulsion of glycerine and sulphur. See the remarks made on this subject under “Excision of the Knee.” Where the pulpy mischief has burrowed out amongst the muscles, where there is osteitis and osteo-myelitis of the bones, amputation is to be preferred, especially if the general condition of the patient is not satisfactory. In flail-like union, where the limb remains quite useless in spite of the use of a leather support,† where the muscles are not helplessly wasted, and no neuralgia is present, re-excision should be tried in preference to amputation, and a trial may be made of uniting the bones with stout silk or with wire.

Other Methods.—I have described excision by a single posterior incision, because I consider that this method gives the best results in the largest number of cases, and is best suited to the majority of operators who will not perform this operation very frequently, and who should, therefore, strive to perfect themselves in one method. The above method is very simple; it affords ample exposure of the joint; its limited interference with the triceps does not prevent the regain of complete extension. Therefore, other methods will be very briefly given.

Ollier's Method by a Bayonet-shaped Incision.—This method, though generally preferred by the above well-known Lyons surgeon, was introduced by him especially for cases in which ankylosis,

* Mr. Whitehead (*Brit. Med. Journ.*, 1872, vol. ii. p. 554) records the case of an adult in which $2\frac{1}{2}$ inches of the shaft of the humerus had to be removed after sawing off the condyles. The patient was the subject of tertiary syphilis, and the operation was performed three years after an injury to the elbow. Nine months later she had full use of the joint.

† See the case mentioned above (p. 66).

which could not be broken down, was present in an extended position. An incision is first made above over the external supra-condyloid ridge, sinking between the triceps and supinator longus about 2 inches above the level of the joint and passing vertically down to the external condyle; the incision then passes obliquely across the olecranon, and below descends upon the posterior border of the ulna for 2 inches. Through this, the main incision, the external condyle, head of radius and olecranon are dealt with. To expose the inner condyle, make sure of the ulnar nerve, and to detach the soft parts and lateral ligament, a second small incision, about $1\frac{1}{2}$ inches long, is made internal to the ulnar nerve and parallel with the inner border of the humerus. The following appear to me to be objections to the above method. In the first place, ankylosis in the extended position is a rare condition, and the union in this or any ankylosed portion of the joint which cannot be safely* broken down under an anæsthetic can be divided, after the back of the joint has been thoroughly exposed by a single vertical incision, by an osteotome or narrow-bladed saw, and the operation completed in the usual way. I have not found that this step "exposes the neighbouring parts to great risk of injury" (Mac Cormac). Further, the central or oblique part of the incision must surely divide the very important outer expansion of the triceps. Finally, while the main incision exposes fully the parts about the external condyle, the small internal one, while introducing a complication, would be inadequate, with most operators, for the separation of parts on the inner side of the wound.

Method by Two Lateral Incisions.—Ollier and Hueter have employed this method largely, especially advocating it in cases of ankylosis. By a small ulnar incision, made vertically, about an inch long, slightly to the front of the internal condyle, the attachment of the flexor muscles and the internal lateral ligament are detached. By a radial incision, 4 inches long, with its centre over the external condyle, the structures on the outer side are next dealt with. The bone-ends may be removed by a narrow saw. It is claimed that this method interferes less with the triceps than that by a single posterior incision, and this is no doubt correct. It is well known, however, that after the latter method complete extension may often be regained. Whether the second chief advantage claimed for this method is correct—viz., that the ulnar nerve does not come into view, and is placed beyond the reach of injury, is, I think, considering the amount that has to be done through a very limited incision, much more doubtful. If lateral incisions are employed I should prefer two freer ones, of $3\frac{1}{2}$ or 4 inches long, and to recognise and draw aside the ulnar nerve.

* In young subjects, where the ankylosis has lasted long and the bones are atrophied, undue force may break one or more of the bones or injure one or more of the epiphyses above or below the line of ankylosis, instead of loosening this.

Such incisions have been employed by Dr. Stimson, of New York, in the treatment of old unreduced dislocations (*Trans. Amer. Surg. Assoc.*, vol. ix. p. 462).

Excision in Cases of Gunshot Wounds.—The following points are brought out by Dr. Otis as the results of this operation in the great Civil War of America (*Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 845 *et seq.*). Compared with excision of the shoulder, the results were less brilliant. The cases are divided into the following groups:—I. *Primary Excisions*.—250 cases, with a death-rate of 21.3 per cent. 27 of the 250 were ultimately amputated. II. *Intermediate Excisions*, *i.e.*, during period of inflammation, three to four weeks.—197 cases, with a death-rate of 35.2 per cent., nearly 14 per cent. greater than that of primary excision. 19 were submitted to amputation later on; 62, or nearly half of the cases, were reported to have complete ankylosis.* III. *Secondary Excisions*, thirty days or more after the injury.—54 cases, with a mortality of 9 per cent.

Period of Election.—Dr. Otis, after remarking that this has hitherto been unsettled, states: "I believe that the evidence, when fully analysed, will demonstrate that this resection conforms to the general rule in shot fractures of the limbs, that primary operations are preferable whenever it is certain that recourse must eventually be had to operative interference." In the future, "intermediate" excision with strict antiseptic precautions and efficient drainage will, probably, be no more dangerous than "primary." The frequency of a flail-joint after "primary" excisions is due (α) to the large amount of bone often removed, (β) to the small reparative power of the periosteum uninflamed at this stage, (γ) to the often necessarily inefficient after-treatment. Sir W. Mac Cormac writes (*Surg. Oper.*, pt. ii. p. 380): "In military surgery most authorities agree that the danger to life is less after a primary resection, but the functional results are not so good, and primary resection is, as a rule, impracticable in the field." In some of the above cases removal of detached fragments seems all that was done. This incomplete operation does not appear to be more successful in military than in civil surgery. As pointed out by Prof. Esmarch, free division of the capsule of the joint deprives the wound of much of its danger.

With regard to the results of this operation in the Franco-German War, Dr. Otis (p. 904) says that the average results met with by the Prussian surgeons are not discouraging, but the results reported by the surgeons attached to the French army of that day are "simply appalling." Dominick has tabulated 263 cases in which the results were accurately noted after the Franco-German War: in 28 cases (10.6 per cent.) there was good active motion, and a more or less useful hand; in 129 cases (49 per cent.) ankylosis took place, in 31 with a useless hand; in 24 cases there was an "active" flail, with a more or less useful hand; in 41 cases a "passive" flail-joint, with a useless extremity.

PARTIAL EXCISION.—The value of this has been disputed. My knowledge of it is limited to two cases which came under my observation with removal of the condyles in the one and the olecranon process in the other. A most unsatisfactory amount of stiffness persisted. In cases of disease I should never recommend it, as it is likely to be followed by imperfect removal of the parts affected as well as by ankylosis. So, too, this step should be

* Thus, if patients escape the risks of operations on inflamed soft parts, bones, &c. (p. 65), the ultimate result may be a fixed joint.

rejected in cases of ankylosis.* In excision for injury it would be permissible to leave the articular ends of the bones of the forearm untouched when it had been needful to remove the end of the humerus very freely. In such cases careful passive movement would be additionally called for. A case in which I resorted to partial excision for injury is given at p. 79.

FIG. 36.



Periosteal elevator and other instruments of very useful pattern for excision of joints. (Farabeuf.)†

Unfavourable Results of Elbow Excision.

1. Persistence of pulpy disease. This is especially likely when, previous to the operation, the capsule has been perforated and pulpy disease has burrowed out amongst the flexors or extensors (p. 73). 2. Caries and chronic osteo-myelitis. These are not unlikely to supervene when the reparative power is poor and the wound becomes septic. 3. Ankylosis. This is not uncommon in children, owing to the great tendency of inflammatory products to organise quickly in early life. Furthermore, there is the difficulty of getting them to use the joint, or submit to passive movement. All they will do is to move their arm and forearm from the

* Sir W. Mac Cormac points out that in these cases to excise the end of the humerus alone will not permit of pronation or supination afterwards, as the upper end of the radius and ulna are soldered together.

† They can be obtained at Hawksley's, 357 Oxford Street.

shoulder-joint (p. 72). 4. A flail-like joint.* A limb may remain weak for some time, owing to the muscles not taking on fresh attachments. Friction and galvanism should be used perseveringly. If there is too much separation between the ends, the patient should wear a well-moulded support; the use of the hand and fingers will thus be retained, and, if the patient is young, gradual and great improvement will very likely take place in the elbow. Re-excision and wiring may be tried in some cases with healthy patients. According to Sir W. Mac Cormac (*loc. supra cit.*, p. 398) most of the flail-joints follow the extensive removal of the lower end of the humerus, especially in cases of injury. In such cases the condyles and their muscular attachments should be as little interfered with as possible. He points out that flail-joints are of two kinds:—(1) Active flail-joints, in which the muscles are strong and exercise control. These may be very useful, especially when aided by a support to the elbow. (2) Passive flail-joints, where the muscles are wasted, and the hand only can be used by the employment of a supporting splint. 5. If the wound becomes septic, cellulitis, erysipelas, &c. 6. Secondary hæmorrhage. This occurred in 11 out of 250 cases. Otis, *loc. cit.*, p. 860. 7. A useless limb, owing to utterly wasted muscles from long disease and disuse. 8. Injury to the ulnar nerve, with its resulting interference with motion, sensation, and nutrition. 9. An adherent scar.

ERASION OF THE ELBOW-JOINT.

This operation has not been extensively practised, partly on account of the good results given by a carefully performed excision, and partly because this joint does not lend itself to free exposure by an incision as simple as does the knee-joint. The statement of some surgeons that in children at the present day excision of joints for tuberculous disease is quite unnecessary, as erosion is perfectly satisfactory, requires qualification. Whatever be the joint, excision can only be perfectly satisfactory if performed in suitable, *i.e.*, early cases. Where the cartilages are not extensively diseased erosion will give better results than excision, but tubercular disease of the joints, and amongst them the elbow, does not always come before the surgeon in its early stage.

Mr. Clutton, at a meeting of the Med.-Chir. Soc. (*Brit. Med. Journ.*, Dec. 16, 1893), advocated early erosion of the elbow-joint in place of late excision. He exposed the joint by dividing the olecranon. Nine cases were thus treated. Of these the first two had ankylosed joints, but very serviceable limbs. Six cases

* Mr. C. Forster (*Lancet*, 1872, vol. i. p. 3) relates a case in which the right limb was a perfect flail, yet with the help of a leather moulded splint all the movements of fingers were good, and the patient could do needlework, and write well. Such a splint is capped to the shoulder and moulded to the limb down to the wrist, leaving the fingers free, and strapped round the chest.

resulted in more or less movement in the joint with cessation of the disease. The ninth and last case was subsequently excised.

While I would first allow that I have no personal experience of erosion of the elbow-joint, I am very doubtful if this operation will give results equal to those of a well performed excision. That in experienced hands erosion will usually remove all the disease, is clear, but here we want a movable, and a freely movable joint as well. Judging from Mr. Clutton's cases I doubt if the latter will be obtained if erosion of this joint comes into vogue on a large scale. And speaking from an experience of some thirty cases of erosion of the knee, I think, after erosion, there must be a tendency to fibrous ankylosis between the ends of the bones which are left. Now this is not a matter of much importance in the lower extremity, where a firm support, as little shortened as possible, is the chief point to be attained to. In the case of the elbow-joint, on the other hand, complete removal of the disease and free mobility are the height of our desires. The latter certainly—and I believe the former also with the majority of operators—will be best attained by excision with free removal of the ends of the bones (p. 72). Next to thorough exposure and complete removal of the disease, a freely movable joint is what we require here, and if this is attained, it matters but little if the limb is shortened.

EXCISION OF SUPERIOR RADIO-ULNAR JOINT.

Indications.—This operation may be, very occasionally, made use of, with antiseptic precautions, in old cases of dislocation of the head of the radius, where reduction has not been effected owing to the amount of swelling, &c., and where the movements of the forearm are much hampered, especially in a young and healthy adult.

Operation.—An incision about 2 inches long is made over the projecting head of the bone behind or through the posterior part of the supinator longus.* The soft parts being separated with a blunt dissector and held aside with retractors, the neck of the radius is carefully divided with a fine saw or cutting bone-forceps. Sufficient bone must be removed here or from the external condyle to leave a gap, and avoid risk of fresh ankylosis. The musculo-spiral nerve lies to the inner side, and great care must be taken not to interfere with this or the biceps tendon. The forearm should be put through its movements freely, but carefully, while the patient is under the anæsthetic, so as to break down adhesions. Sufficient drainage must be provided, and every care taken, by not interfering with the soft parts more than is absolutely needful.

* The operation will be somewhat easier in the backward dislocation, when the radius rests on the back and outer surface of the external condyle, than in the forward displacement, when the head rests on the front of the humerus in the hollow above the condyle.

and by keeping the wound aseptic, to secure primary union, and thus avoid the risk of stiffness again occurring. After a few days a sling may be substituted for a splint, and passive movements made use of daily, with the aid of an anæsthetic if needful.

In October, 1894, I excised the head of the radius in the following obscure and instructive case:

In the previous August the lad, aged 12, had fallen from a ladder partly on to his feet, partly on his right elbow, not on the hand. Much swelling of the joint had followed with subsequent stiffness, rendering the limb very useless. Passive movement had been tried, but the patient had done his best to render the result negative. The forearm was fixed in a position midway between pronation and supination, and flexed at a right angle. No flexion possible beyond this. Passive extension to about 120° . Pronation and supination, passive and active, quite abolished. A prominence—? the head of the radius—to be felt below the external condyle, but not admitting of rotation; there was no crepitus. Dr. Harsant, of Clifton, sent me the case as one probably of dislocation of the head of the radius, and with this view I agreed, though against it were the history of direct violence and the absence of any rotation in the swelling. On exploration of the injury by a free lateral incision, it turned out to be one of those rare cases of fracture through the neck of the radius. Just below the external condyle the head of the radius was found separated from the shaft by a fracture through the upper part of the neck, and lying with its articular surface turned directly outwards. On removal of this there was distinct improvement in pronation, but little in supination. Flexion was now possible to 40° , and extension to the almost complete range, but only on forcible movement. As the movements were still incomplete, and certainly would not be retained, I removed the articular end of the humerus from the same incision with a narrow osteotome. The forearm could now be put through its full range of movements. The wound healed under an aseptic clot, and the patient, when he left my care five weeks later, had recovered almost complete active movements of the joint, though the whole limb was still weak. Three months later I heard that he could "do everything nearly as before the accident, and that he could also carry considerable weights."

Mr. Wainwright (*Clin. Soc. Trans.*, vol. xix. p. 332) records a somewhat analogous case, in which, in an adult, he removed the head of the radius, which was vertically fractured, and the coronoid process, which had been imperfectly united with fibrous tissue. The accident had taken place three months before. The movements of the limb were distinctly improved by the operation.

UNUNITED FRACTURE OF OLECRANON.

Wiring the fragments of this bone is not often required. For fuller details the reader is referred to the remarks on treatment of ununited patella by wiring.

Indications.—(1) Where, in spite of careful treatment, the limb is weak and its usefulness seriously interfered with, especially where the occupation of the patient requires vigorous extension of the elbow.* (2) Where such treatment has not been used, but the time for it has gone by. In either case the patient should be young and healthy. The object of the operation and

* The surgeon will examine how far this power is lost, to what extent the triceps has wasted, and what evidence of union there is between the fragments.

its possible risks should be fully explained to him. It is taken for granted that a surgeon undertaking this operation has good reason for feeling confident in his knowledge of antiseptic surgery.

Operation.—The parts being rendered evascular by properly applied Esmarch's bandages, and the region of the elbow-joint duly cleansed,* a longitudinal incision is made for $2\frac{1}{2}$ or 3 inches over the back of the joint, opening this and exposing the fragments. Any adhesions—*e.g.*, between the upper fragment and the humerus—are then removed or broken down. Retractors being placed in the wound, any fibrous tissue is separated from the contiguous edges of the fragments, and a thin layer of bone removed from each, either with a chisel or a narrow, sharp saw. I prefer the latter. Mr. Treves, who uses a chisel, steadies the fragments by lion-forceps, the blades of which are without teeth. A hole is then drilled obliquely through each fragment with a bradawl or drill, and stout † silver wire passed ‡ and twisted up. Two half-twists or one complete twist should be sufficient. If the surgeon decides to leave the wire in, he now cuts the ends short and hammers them down upon the olecranon with a small hammer. If he is going to remove them later on, he leaves the ends, not cut too short, projecting through the wound, which is next closed with silk or wire sutures.

Two questions arise here. One, Should the wire be left or no? I have alluded to this question more fully later on, in the treatment of fractured patella by wiring. While one objection there given is wanting here—*viz.*, the inability to bear pressure on the wire, as in kneeling—two others remain—*viz.*, the fact that, in some patients, attention has been constantly attracted to the pricking of the wire, and that, after a time, ulceration may set in around this and cause trouble. Thus I believe it to be better in most cases to leave the wire ends fairly long, not short and hammered down, and to remove them in four or six weeks' time. The other course no doubt enables the surgeon to allow his patient to return to work after a much shorter interval—*viz.*, three or four weeks—but, as I think, at an undoubted risk.

The other question is about the drainage. If the parts have not been much interfered with, if no separation of adhesions has been necessary, probably no drainage will be needful, if dry gauze dressings are applied, and firm and even support given with bandaging. If drainage is considered advisable, a catgut drain will probably be sufficient.

* First by the use of soap and carbolic oil, and then with carbolic acid lotion (1 in 40), a piece of lint soaked in this being worn over the joint for a few hours before the operation.

† Sir J. Lister (*Lancet*, 1883, vol. ii. p. 761) gives wire about $\frac{1}{8}$ of an inch as amply sufficient for the olecranon, while for the shaft of the femur, in an adult male, a piece of wire about $\frac{1}{16}$ of an inch in thickness is requisite in order to resist with certainty the enormous force of the great muscles of the thigh.

‡ For difficulties in this, and how to meet them, see "Wiring of the Patella."

Movement should be begun about the third week, and continued with the persevering and intelligent co-operation of the patient. If the union is firm, the wire may be removed a little later, careful note having been made, at the time of the operation, of the number of half-twists. Occasionally here,* as in the case of the patella, removal of the wire is a matter of some difficulty.

VENÆSECTION.

Indications.

1. Some cases of pneumonia after injury, as where a plethoric young farmer breaks several ribs when riding, and acute pneumonia sets in and extends rapidly.—Here the cyanosis, orthopnoea, the distressing pain, may all be relieved by a bleeding of 8 to 10 ounces, which very likely will have to be repeated.

In other cases of acute pneumonia which are not traumatic, bleeding may be resorted to with great advantage when the patient is young and of full habit, the breathing much oppressed, and the heart's action becoming embarrassed.

2. In some cases of chronic bronchitis.—Dr. Hare † draws this graphic picture of such a case.

A middle-aged man with chronic bronchitis and some congestion of the lungs has exposed himself to chill. "He is sitting in a chair (to lie down is impossible for him), his face is blue and sunken, his lips purple, the eyes suffused and staring . . . his chest heaving, and each short gasping inspiration followed by a long wheezing and moaning expiration; his lungs are full of moist, sonorous, and mucous rhonchi, scarcely a trace of vesicular murmur is to be heard, and he is pulseless. He looks to you beseechingly, and gasps out, in scarcely articulate words, that he is dying. This is but true. Now, the treatment for such a condition at the present day is to 'pour in stimulants' (though the patient can scarcely swallow). Brandy and water are given, and ammonia, and perhaps ether; then, if the patient lives long enough, mustard poultices are applied to the chest and the calves and feet, and the patient is fanned, and the patient dies. . . . Appearances have been saved, but not the patient's life. The fact is that here the danger lay in the right side of the heart being gorged with blood, so that it was impossible for its stretched and distended walls to contract and to propel forwards the thick and blackened blood. . . . Open one of these veins, which are, with every systole of the heart, tending to carry more and more blood to this already distended right ventricle, and all may yet be well with your patient."

3. Where a tendency to apoplectic seizures exists.‡—Dr. Hare

* In a case of Sir J. Lister's (*loc. supra cit.*), the wire was not completely removed from the olecranon, for, the loop having given way near the twist, the twisted part was alone taken away, and the loop left behind, but without causing any inconvenience when the patient was last heard of.

† *Brit. Med. Journ.*, 1883, vol. i. p. 156: "Good Remedies out of Fashion." Very interesting papers (with cases) will be found by Dr. Pye Smith (*Med.-Chir. Trans.*, vol. lxxiv. p. 147), Dr. Ogle and Dr. Wilks (*Lancet*, vol. i. 1891, pp. 1029, 1139).

‡ This does not mean those cases where a rupture of a cerebral vessel has occurred, and where bleeding would interfere with that process of repair on which the patient's life depends.

(*loc. supra cit.*) thus writes of this class of case. Nature speaks "in unmistakable language when by a copious epistaxis she efficiently relieves the congested turgid face,* the beating temples, the dull heavy headache, the sleepiness, the confusion of thought, and other symptoms, which, in a plethoric individual betoken, if they are not relieved, serious danger, if not an apoplectic attack."

4. In aneurisms, especially thoracic.—As part of the treatment of Valsalva in a modified form. Formerly the bleedings in aneurism were copious even to syncope. Nowadays they are made use of differently. They are small in amount, and are only repeated so far as to reduce excessive action of the heart, or to relieve certain symptoms (as they undoubtedly do)—viz., dyspnœa and pain.

Dr. MacDougall, of Carlisle, in a most interesting paper (*Amer. Journ. Med. Sci.*, 1887, p. 38) points out the following as cases in which venæsection should be used more often when other means have failed. (1) Details are given of a case of mitral and aortic incompetence, with chronic Bright's disease, and acute pleuropneumonia, in which recovery followed epistaxis to the amount of a pint. (2) Reaction after concussion, with a full, slow, labouring pulse, and headache. (3) In epilepsy in strong, big, healthy patients, venæsection will relieve the cerebral stasis. (4) In some cases of "croup," in late childhood, or in vigorous adolescents. (5) In acute pleurisy, with intolerable pain, unrelieved by morphia; where there is not much effusion, but lymph formation over a wide surface. (6) Very rarely in acute pneumonia, bilateral, in young healthy subjects, with small pulse and strongly beating heart. It is pointed out that the pyrexia here favours the dilatation of the right side of the heart. (7) In suffocative pulmonary catarrh, with a trace of albumen and a few granular casts. (8) In some cases of convulsions, *e.g.*, (a) after scarlatinal nephritis; (b) in parturient or pregnant women—*i.e.*, in severe attacks, with extreme congestion, profound coma, and hard pulse; (c) in plethoric coma, preceded by headache, in full-blooded women about the time of the menopause.

Operation.—The patient being usually in a sitting position, and a bandage tied round the middle of the arm with sufficient tightness to retard the venous circulation without arresting that in the arteries,† the surgeon selects the median cephalic or the median basilic, whichever is most prominent.‡ Steadying this

* Dr. Copeman (*Brit. Med. Journ.*, 1879, vol. ii. p. 932) points out that in these cases, in addition to plethora and a full habit, evident distension of the superficial veins of the head and neck is a valuable indication that bleeding is proper.

† The surgeon makes use of the pulsation in the arteries to tell the relation of the brachial, or one of its branches given off abnormally high up and running superficially to the veins at the bend of the elbow (p. 96).

‡ If the patient is nervous, or if the veins are small, he should be told to hold a walking-stick or book. This steadies his arm, distract his thoughts, and by producing muscular contraction supports and fills the veins.

vein by placing his left thumb upon it just below the point of intended puncture, and with his right hand resting steadily upon its ulnar margin, he opens the vein with a scrupulously clean lancet or small sharp scalpel, making with a gentle sweep of his wrist a small incision, and not a mere puncture, into the vein. The anterior wall of this being divided, the point, without penetrating any deeper, is thrust onwards, first increasing the slit in the vein, and then being brought out vertically, care being taken to make the skin wound larger than that in the vein. The thumb is now raised and the stream directed into the measuring-vessel.* While the blood is escaping, the limb should be kept in the same position, lest, by the skin slipping over the wound in the vein, the blood should be prevented from escaping freely and make its way into the cellular tissue.

The required amount of blood having been removed, the thumb is placed on the wound while the bandage is removed. A small pad of lint dusted with iodoform or of dry aseptic gauze is then placed on the puncture, and secured with tape or bandage applied in the figure of 8. This pad may be removed in about forty-eight hours, and for a day or two the patient should use a sling.

Difficulties during, and Complications after, Venæsection.

1. Difficulty in finding a vein.—This may be due to their small size, the feebleness of the circulation, or the abundance of fat. If a vein cannot be made sufficiently distinct by hanging down the limb, putting it in warm water, flexing and extending the wrist and fingers, and chafing the limb, a vein should be opened on the back of the hand, or blood withdrawn from the external jugular or internal saphena at the ankle.

2. In other cases, where the patient is much emaciated, owing to the absence of steady fat the mobility of a vein may enable it to avoid puncture, unless a very sharp instrument is used and the vein well steadied.

3. When the vein has been opened, sufficient blood may not escape owing to—

(a) The opening may be a mere puncture. (b) The skin opening may be insufficient in size, or not parallel in position to that in the vein. These impediments are removed by a freer use of the knife, carefully made, or by bringing the wound in the vein parallel with that in the skin. (c) A pellet of fat may block the opening in the vein. This should be snipped away. (d) The patient may faint. (e) A thrombus may form. This will disappear when the venous current becomes more active. (f) The bandage may be tied too tightly round the arm.

4. Wound of the brachial or some other artery—*c.g.*, an abnormal ulnar.—This can always be avoided by a careful use of the lancet or scalpel, and by noting beforehand the existence of any pulsation. The force of the jet and the mixture of bright

* Not a drop of blood should be allowed to go on to the bed or patient's linen

with dark blood will tell of this accident. Pressure should be carefully applied and maintained (p. 24), and blood taken from the opposite arm if required.

5. Escape of blood into the cellular tissue.—This will lead to ecchymosis, and perhaps formation of a thrombus, which may be absorbed, but which also may suppurate.

6. Phlebitis, or inflammation of the lymphatics.—These may be due to use of dirty instruments, aided by the low condition of the patient. They should be most carefully guarded against, as likely to lead to the following two most grave results:

7. Erysipelas and cellulitis.

8. Intense pain in the limb, with gradual flexion of the elbow-joint.—This is due to puncture of the external or internal cutaneous nerves, which are connected through the brachial plexus with the motor nerves to the brachialis anticus and biceps, which flex the elbow-joint.* The injured nerve should be divided, subcutaneously if possible; or the scar excised.

INFUSION OF SALINE FLUID. TRANSFUSION.

These operations of late years have been so much simplified, especially in the matter of saline injections, that every practitioner should be ready to perform the latter operation, owing to the critical nature of the cases which call for it, and the suddenness with which the call is liable to come.

INJECTION OF SALINE FLUIDS.

While this method had been occasionally made use of by many different workers for many years, *e.g.*, the Littles in the cholera epidemics at the London Hospital in 1848 and 1866, and many others, sporadically, at most of our hospitals, it was the late Dr. Woolridge† who showed in this country‡ by experiments which are unpublished owing to his untimely death, that, after hæmorrhage sufficient to be fatal, enough hæmoglobin still remained to sustain life, if only sufficient fluid was added to keep it in circulation. Further, it was Mr. Arbuthnot Lane who, applying the above experiments to surgery in two brilliantly successful cases,§

* Hilton, *Rest and Pain*, p. 190

† *Lancet*, vol. i. 1891, p. 626. *Brit. Med. Journ.*, vol. ii. 1892, p. 491.

‡ Dr. Herbert R. Spencer, *Lancet*, vol. i. 1892, p. 1289, considers that Golz (*Virch. Arch.*, Bd. xxi. and xxix.), and Kronecher and Sander (*Berlin. Klin. Woch.* 1879, No. 52), were the first to suggest saline infusion and explain its action. Dr. Spencer claims (*loc. supra cit.*) the first successful case of injection of saline fluid in a patient the subject of post-partum hæmorrhage as long ago as April 1888.

§ One of these cases is published (*Lancet*, vol. ii. 1891, p. 626). The other was a case admitted for hæmorrhage after partial removal of the tonsil. Here, by ligature of the common carotid and injection of saline fluid, the patient was rescued from the very gravest peril.

again drew the attention of the profession to the value of this method more forcibly than had been done before.

In his three lectures on transfusion which Dr. William Hunter gave before the College of Surgeons (*Brit. Med. Journ.*, vol. ii. 1889, pp. 117, 237, 305), and which contain the most recent scientific information on this subject with which I am acquainted, the advantages of transfusion and injection of saline fluid are contrasted, and the following most important conclusion arrived at (p. 309): "For practical purposes all the advantages to be gained by transfusion, may, I believe, be equally well and more readily obtained by infusion of a neutral saline, such as $\frac{3}{4}$ per cent. solution of common salt (about 1 drachm to the pint)." It is clearly shown in these lectures that with regard to transfusion, the nutritive value of *serum* is so small that its chief value here must depend upon its physical properties, and these are in no respect greater than those of a corresponding quantity of neutral saline solution. With regard to the *red corpuscles* the same authority writes (*loc. supra cit.* p. 305): "the greater the quantity of blood transfused, the longer are red corpuscles likely to remain within the circulation, and the more likely is their hæmoglobin and the iron which it contains to remain within the system. Over this factor, however, we can execute but little control. The quantity of blood transfusible in man can rarely be more than about 5 per cent. of the blood already in the body. And the life duration of the red corpuscles under such circumstances is probably to be reckoned by a period of hours." Again, a little later (p. 308), we are told on this subject that, "it may be stated that there is scarcely a single condition of the blood in which the want of red corpuscles is a source of urgent danger. After the greatest loss of blood in animals, a sufficient number of red corpuscles always remains in the circulation to carry on respiration, provided that the circulation is maintained. . . . In man the loss of blood can never be so great as in animals. Syncope occurs earlier. Transfusion of blood is, therefore, never required for the purpose of supplying red corpuscles to carry on respiration after sudden loss of blood in a patient previously healthy. The immediate source of danger in such cases is not the want of red corpuscles, but the disturbance of the relation between the vascular system and its contents. . . . The immediate source of danger from sudden loss of blood is the fall in the blood pressure to a point where the circulation is unable to be maintained. The obvious indication, therefore, is to raise the pressure within the vessels." Dr. Hunter then points out that *bulk for bulk* pure or defibrinated blood must possess a certain physiological value—*e.g.*, a greater and more immediate effect in restoring the tone of the vaso-motor centre than saline solutions. "These advantages, however, are more than neutralised by the greater disadvantages—namely, (1) the difficulty of obtaining blood in sufficient quantity or sufficient rapidity as compared with the ease with which simple

saline solution can be prepared; (2) the danger attending the transfusion if compared with the absolute freedom from danger possessed by salt solution; and (3) the doubtful value of the transfusion, whether hæmogenic or physical, when compared with saline fluid." The chief indications are:

1. Acute traumatic anæmia, such as hæmorrhage after accidents, operations, cut throat, and that connected with child-births.—Five most carefully reported and instructive cases, under the care of Mr. Pye Smith, of Sheffield, will be found in the *Lancet*, vol. i. 1892, p. 913; of these three were successful. In two Mr. Pye Smith made use of the infusion of saline solution *before* the amputation. Dr. Herbert Spencer's paper, already referred to, gives good instances of the cases in which infusion may be resorted to with benefit in the hæmorrhage of child-birth—*e.g.*, cases of accidental hæmorrhage, placenta prævia, and adherent placenta.

2. Collapse and shock.—Here infusion of saline solution may also be resorted to, but less hopefully, with a view of stimulating the weak action of the heart and combating the loss of vascular tone which accompanies it. The injection of strychnia (gr. $\frac{1}{20}$ of the sulphate) hypodermically is especially indicated here.

The late Dr. Sturges published (*Lancet*, vol. i. 1892, p. 86) a case in which severe collapse from vomiting and diarrhœa in a child of nine months, the subject of congenital syphilis and rickets, was successfully tided over by the infusion of salt solution injected by Mr. Horace Collier. Other treatment having failed, the left external jugular was exposed, and 12 ozs. of distilled water containing 36 gr. of common salt and rather more than a drachm of brandy was slowly injected. The very marked restlessness which followed was combated with opium. The child recovered.

Method.—The instruments used should be as simple as possible. A teaspoonful of common salt is dissolved in water which has been recently boiled. About four pints of such a solution should be at hand, and kept at a temperature of about 100°. The skin being cleansed over the vein selected—usually the median basilic or cephalic—two catgut threads are passed under this. The lower being tied around the nozzle of the cannula (one of glass, metal or vulcanite may be used as long as it is of appropriate size and rendered aseptic) by means of a piece of india-rubber tubing, any convenient syringe is attached to the cannula and the fluid slowly injected. About two pints is the amount usually required, but four or even six may be needed. The chief guides are the return of the pulse, with increase in volume and diminution in rate (say a fall from 130 to 90), return of colour and fulness to the face, increase in consciousness, &c. The operation being completed, the remaining ligature is tied just below the opening in the vein and the little wound closed and dressed with aseptic precautions.

If the vein desired is not readily found a free transverse incision should be made in the subcutaneous fat. Or any other vein may be chosen which can be rendered prominent—*e.g.*, the internal saphenous or the external jugular.

TRANSFUSION.

As it is still disputed how far transfusion of blood is useful in such diseases as pernicious anæmia, this operation will be described here, though it is clear that in the very great majority of indications it has been replaced by infusion of saline solution, chiefly on account of the difficulty with which sufficient amount of blood is obtainable.

With regard to transfusion in pernicious anæmia, Dr. Hunter (*loc. supra cit.*) spoke as follows: "In idiopathic anæmia, pernicious anæmia, and leucocythæmia, transfusion of blood can, in my opinion, never be indicated. In both the condition of the blood is the result of changes in the blood-forming or blood-destroying processes, or both. In leucocythæmia the disturbance is one of blood-formation in the first instance, evidenced by the increase of the leucocytes of the blood, while the diminution in the number of the red I find to be due in great part to excessive blood destruction, probably induced by the activity of the leucocytes. In pernicious anæmia, the condition of the blood is mainly the result of excessive destruction. Transfusion of blood under such circumstances is not unattended by dangers, as we have seen, but is followed in most cases by rapid destruction of the red corpuscles, as evidenced by fever, sometimes by hæmoglobinuria, occasionally also by increase in the slight icterus which so frequently marks the progress of the disease." On the other hand, at a meeting of the Edinburgh Medico-Chirurgical Society (*Lancet*, vol i. 1892, p. 24), Dr. Brakenbridge and Dr. Affleck claimed successful cases.

Dr. J. R. Philpots (*Brit. Med. Journ.*, vol. i. 1894, p. 162) also mentions a successful case in which the transfusion was performed by Mr. C. E. Jennings. Here 16 oz. of blood were transfused, the blood mingling "in its passage with about 10 ounces of saline fluid, and about 16 ounces of saline fluid were infused into the donor's veins to replace the blood given."

One other condition in which transfusion of blood, aided perhaps by infusion of saline solution, may be beneficial, is poisoning by carbonic oxide gas. Here, perhaps, it would be well to get rid of some of the poisoned blood by a preliminary blood-letting.

There are two methods—A. Direct, in which blood is conveyed directly from one person into another; and B. Indirect, in which blood separated from its fibrin, or some other fluid is thrown in.

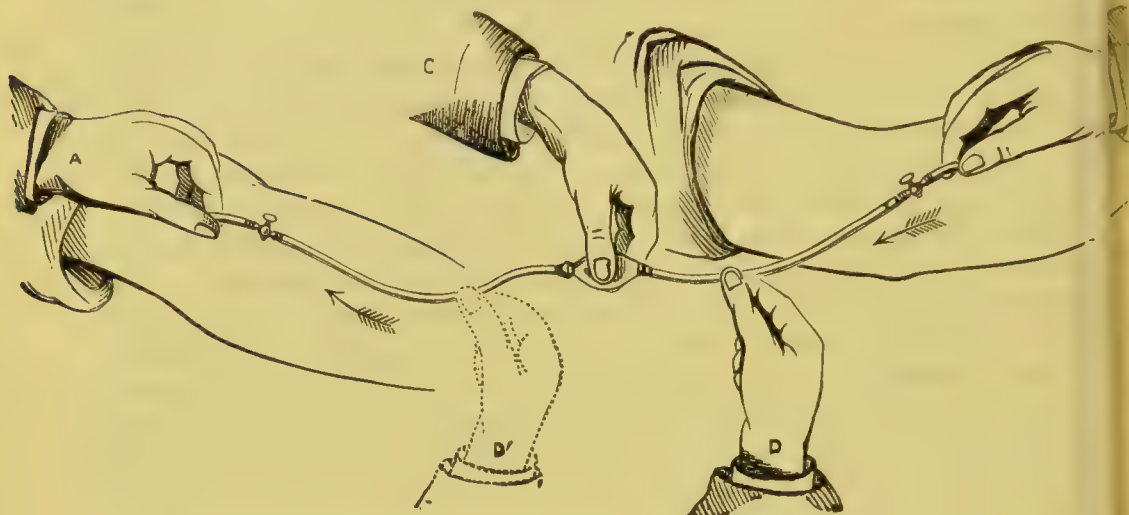
Direct.—Owing to want of space I shall describe this alone. It is probably preferable to inject blood without exposure to air and without manipulation in the few cases in which this method is called for—*e.g.*, pernicious anæmia.

Method.—(Fig. 37). DR. AVELING'S MODIFIED BY MR. CRIPPS.—As I have only space for one here, I shall describe that with which

I am most familiar. It is simple and inexpensive,* and has the advantage of measuring the blood sent—viz., 2 drachms at each squeeze of the bulb.

The veins being exposed and probes passed beneath them, the apparatus is filled with a warm solution of sodium chloride, and a clip placed at either end. The arms of receiver and donor being in the position given below, the vein of the receiver is opened with

FIG. 37.



A and B are the hands of assistants holding the afferent and efferent tubes and the lips of each venæsection wound together. The cannulæ being inserted into the veins, the bulb and tubing, filled with warm saline solution, and kept so by the taps or clips, are fitted into the cannulæ. Then the taps are turned or the clips removed, and the tubing compressed by D, and the bulb squeezed by C. The tube is then squeezed by shifting D to D'. The bulb then expanding draws in blood, when the manipulation just described is repeated. The bevelled end of the afferent tube is so made that it may slip easily into the collapsed vein of the patient. (Aveling, *Obst. Trans.*, vol. vi. May 4, 1874.)

sharp scissors, and pressure being made just below the opening in the vein, so as to prevent blood obscuring the opening, the cannula is inserted. The other cannula is then inserted into a vein of the giver, and both held steadily by an assistant. Transfusion is then performed as follows:

“The clips having been removed from the tube at either end, the operator makes the necessary valve to prevent regurgitation by compressing, with the finger and thumb of one hand, the tube between the central ball and the giver. He then slowly squeezes the ball, with the effect of driving the water it contains gently

* I may remind my readers that, as in the case of all india-rubber instruments, this, unless kept carefully and looked at from time to time, is liable to be found cracked and useless at the moment of need. I believe the only means of really ensuring the preservation of india-rubber is to keep it under water. Mr. Cripps (*Dict. of Surg.*, vol. ii. p. 660) has removed one source of clotting by replacing with clips the taps shown in Fig. 37.

into the vein of the recipient; then, having compressed the tube between the ball and the recipient, he removes the finger and thumb from off the tube on the opposite side, allowing the ball to expand with the blood coming into it from the arm of the giver. When the ball is full, the manipulation just described is repeated, and the blood passes into the vein of the receiver. In this manner, each time the ball is compressed 2 drachms of blood are injected into the veins of the patient. Should the syringe appear to become blocked,* or work unsatisfactorily, it can be detached and washed out without removing the cannulæ from the veins."

Risks and Dangers of Transfusion.—Amongst these are:—

1. Emboli and their results.

Dr. W. Hunter (*loc. supra cit.*, pp. 306, 307) points out that very grave symptoms, due to wide-spread thrombosis and spasm of the capillaries, especially of those of the gastro-intestinal mucous membrane and lungs, may follow on transfusion of blood with or without sodium phosphate. The most frequent of these are abdominal pain, diarrhœa, albuminuria, hæmoglobinuria, &c. Furthermore, one great feature of defibrinated blood, however obtained, is the uncertainty of its action. It is sometimes quite harmless, at others highly dangerous, this result being entirely independent of the quantity injected or the care taken in injecting it.

It has been suggested that some saline solution having the power of delaying the coagulation of blood—*e.g.*, sodium phosphate—should be added to the blood before it is transfused. (Braxton Hicks, *Guy's Hosp. Reps.*, vol. xiv.) Dr. W. Hunter (*loc. supra cit.*, p. 305) condemns the use of this salt. He is of opinion that the use of even a $\frac{3}{4}$ per cent. solution of sodium phosphate will cause red corpuscles to break up within 24 hours, and that the use of this salt along with blood will not prevent the occurrence of those capillary thromboses which are known to follow on transfusion of blood by itself.

Except for those cases where infusion of saline solution has failed, or where, as in pernicious anæmia, it is desired to inject blood and to add to the amount injected, it is not likely that the employment of sodium phosphate will be continued.

2. Evidence of blood being thrown in too rapidly for the system of the receiver—*e.g.*, headache, flushing, præcordial oppression, &c.

3. Perhaps septic absorption, if the blood has been exposed too long, or if milk is used.

The use of milk, which has been used by some—*e.g.*, Dr. Thomas, of New York—as safer and more nutritious than saline infusion, should be rejected absolutely. Both claims are quite unfounded for infusion purposes. Dr. Schäfer (*loc. supra cit.*) found that the

* A case in which this occurred will be found related by Dr. Hoggan, *Brit. Med. Journ.*, 1877, vol. ii. p. 726.

injection of milk, after dogs had been reduced by bleeding to an almost lifeless condition, caused a temporary rise in the blood-pressure, but no permanent benefit. After death the blood corpuscles were found to be disintegrated, and the blood swarming with bacteria.

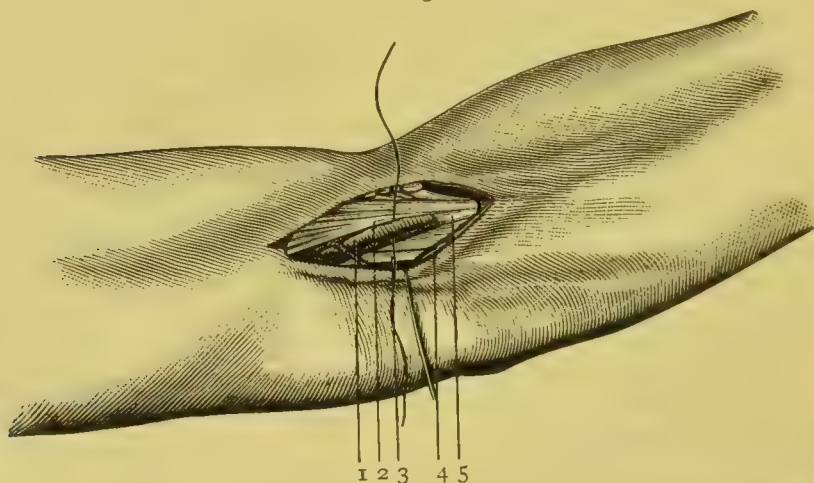
4. Many of the risks already given under the head of venæ-section (p. 83) will, of course, be present here also.

LIGATURE OF THE BRACHIAL ARTERY AT THE BEND OF THE ELBOW (Figs. 25, 38 and 39).

This operation, common enough fifty years ago owing to the frequency of bleeding and the facility with which the brachial artery was wounded, will be briefly described here.

Indications.—(1) Wound of artery, especially after bleeding or tenotomy of the biceps tendon. (2) Traumatic arterio-venous aneurism also occurring after bleeding.

FIG. 38.



Ligature of brachial artery at the bend of the elbow. 1. Artery surrounded by its venæ comites, from the inner of which a branch passes to 4 (basilic vein). 2. Bicipital fascia. 3. Median nerve. 4. Basilic vein. 5. Biceps tendon. Too much of the artery is shown cleaned.

GUIDE.—The inner side of the biceps tendon.

RELATIONS:— **IN FRONT.**

Skin; fasciæ; bicipital fascia; median basilic vein. Branches of internal and external cutaneous nerve.

OUTSIDE.
Biceps tendon.
Vena comes.

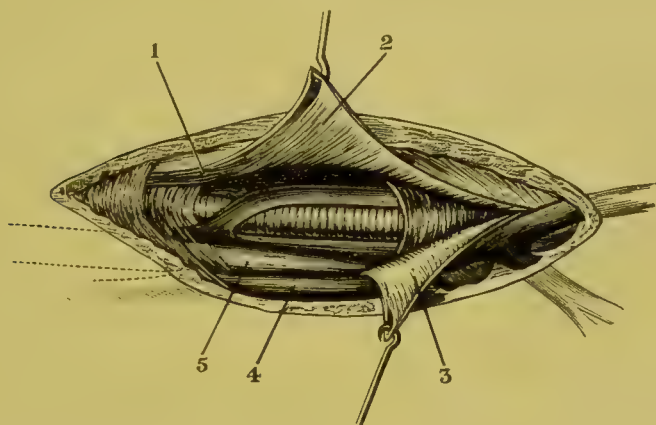
Brachial artery
at bend of elbow.

INSIDE.
Median nerve
Vena comes.

BEHIND.
Brachialis anticus.

Operation (Figs. 25, 38 and 39).—The limb being steadied with the elbow slightly flexed, the site of the biceps tendon should be defined, and also that of any large veins, by making pressure a little above the proposed site of ligature. An incision about 2 inches long is then made, a little to the inner side of the biceps tendon, through the superficial fascia carefully, so as to avoid the median basilic vein and its companion, the internal cutaneous nerve. If these are seen, they must be drawn inwards. The deep fascia is then divided on a director, this and the semilunar fascia of the biceps which strengthens it being interfered with as little as possible. The artery, with its venæ comites, lies directly underneath. The needle should be passed, after the veins are separated and the artery cleaned, from within outwards, so as to avoid the median nerve, which lies more deeply on the inside.*

FIG. 39.



Wound at bend of elbow (left) for ligature of brachial artery shown dissected. 1, 2, 3. Tendon of biceps and outer and inner flaps of bicipital fascia. 4. Basilic vein. 5. Median nerve. The artery is seen surrounded by its two venæ comites, the sheath having been freely removed. (Farabeuf.)

In the case of traumatic arterio-venous aneurism resisting other treatment, the old operation of placing double ligatures† will be

* If it is needful to prolong the incision downwards so as to secure the upper end of the radial or ulnar, the bicipital fascia must be divided more freely, and the median basilic vein secured if it cannot be drawn to one side.

† Here ligatures will be required above and below the communication with the vein in the case of aneurismal varix, and above and below the sac if the surgeon is dealing with a varicose aneurism, it being understood that palliative treatment has not sufficed, and that pressure, applied locally and on the main trunk above, or by means of Esmarch's bandage, has failed. If ligature is decided upon, it will be better (the artery being commanded above) to open the sac, and thus find the apertures into the artery by the aid of a small bougie. As Mr. Holmes (*System of Surgery*, vol. iii. p. 92) points out, the other plan of attempting to find and tie the artery without opening the sac presents these difficulties—viz., that the artery is surrounded by dilated and closely packed veins, and that below the sac it is of small size.

preferable to the Hunterian one, which runs the risk of overlooking the possibility of a rather higher division than usual of the brachial into radial and ulnar. If much hæmorrhage is expected, the brachial should be compressed about the middle of the arm with an Esmarch's bandage, or the vessel controlled by a reliable assistant. The median basilic vein will, in such cases, be often found much dilated by the entrance of arterial blood. In others it has been obliterated.

This operation at the bend of the elbow should always be performed with the utmost carefulness at the time, and pains taken with the after-treatment, so as to insure the minimum of disturbance and the smallest amount of cicatrix, and thus to interfere as little as possible with the movements of the elbow.

CHAPTER V.

OPERATIONS ON THE ARM.

LIGATURE OF BRACHIAL ARTERY (Figs. 40, 41 and 49).

THIS is performed (*a*) in the middle of the arm, and, much more rarely, (*b*) at the bend of the elbow, the operation last described.

(*a*) **In the Middle of the Arm** (Fig. 40).

Indications.

1. Chiefly wounds of palmar arch, resisting pressure (p. 24).
2. Wound of the artery itself by penknife,* bayonet, bullet, &c.
3. Gunshot wound of the elbow, leading to secondary hæmorrhage resisting other treatment.
4. Angeioma of hand.

In March 1891, I tied first the brachial, and, five months later, the radial and ulnar arteries, for a congenital angeioma with much erectile tissue affecting all the fingers and the palm of the hand in a girl aged 18. By the first operation the vascularity was quickly reduced, the second, aided by catgut setons, was followed by very marked shrinking, and, ultimately, a complete cure.

5. Wound of one of the arteries of the forearm, when hæmorrhage has occurred from a wound of one of these, and the parts are in a sloughy condition.

In the year 1882 a patient came under my care for secondary hæmorrhage from a wound of the forearm, inflicted by the bursting of a gun in rook-shooting. The parts were much swollen and sloughy; the ulnar artery in its middle third, from which the hæmorrhage was coming, was greenish in colour, and apparently not in a condition to hold a ligature. A good recovery, with no further hæmorrhage, took place after ligature of the brachial in the middle of the arm. In 1885 I had occasion again to tie this artery for hæmorrhage occurring, repeatedly, a few days after a suppurating palmar bursa had been opened in the usual way, above and below the anterior annular ligament. The patient recovered with a weakened limb.

6. Traumatic and spontaneous aneurism. As is well known,

* Mr. Sheild (*Lancet*, 1837, vol. i. p. 978) has recorded a case of stab wound of the brachial with many points of interest. A penknife wound had reached the artery by passing from without inwards through the biceps. The bleeding was arrested by pressure. The wound healed, and twenty days later a fall caused the cicatrix to give way, profuse hæmorrhage following. Esmarch's bandage being applied, a free incision was made, and the bleeding point found by searching with a bent probe, the end of which passed into an opening in the brachial artery. Ligatures were applied above and below. Owing to the swelling of the arm no sutures were used. A good recovery took place.

spontaneous aneurisms are very rare in the upper extremity, and usually associated with cardiac disease. Treatment here should not be too active; ligature should only be thought of where the aneurism is rapidly increasing, or causing painful pressure upon a nerve. Traumatic aneurism is decidedly under the influence of pressure. If this fails, it is a question if the old operation is not superior to the Hunterian, for the sac is often imperfect.*

LINE.—From the junction of the middle and anterior thirds of the axilla, along the inner edge of the coraco-brachialis and biceps, to the middle of the elbow triangle. This line is of especial importance

FIG. 40.



The upper hook draws aside the biceps and the median nerve; the lower the basilic vein and the triceps. The inner vena comes is seen in the bottom of the wound. The sheath of the artery has been opened and a small portion cleaned ready for the passage of the ligature.

when, owing to swelling, &c., the edge of the biceps is difficult to make out.

GUIDE.—The above line and the inner edge of biceps.

RELATIONS in arm :— IN FRONT.

Skin; fasciæ; branches of internal and external cutaneous nerves.

Median nerve† (about the centre of the arm).

OUTSIDE.

Coraco-brachialis (above).

Biceps.

Vena comes.

Brachial
artery
in arm.

INSIDE.

Ulnar nerve.

Internal cutaneous nerve.

Vena comes.

Basilic vein, superficial to deep fascia in lower half. beneath it above, usually.

BEHIND.

Triceps (middle and inner heads); coraco-brachialis; brachialis anticus.

Musculo-spiral nerve and superior profunda artery (above).

* Holmes, Roy. Coll. Surg. Lect., *Lancet*, October 25, 1873.

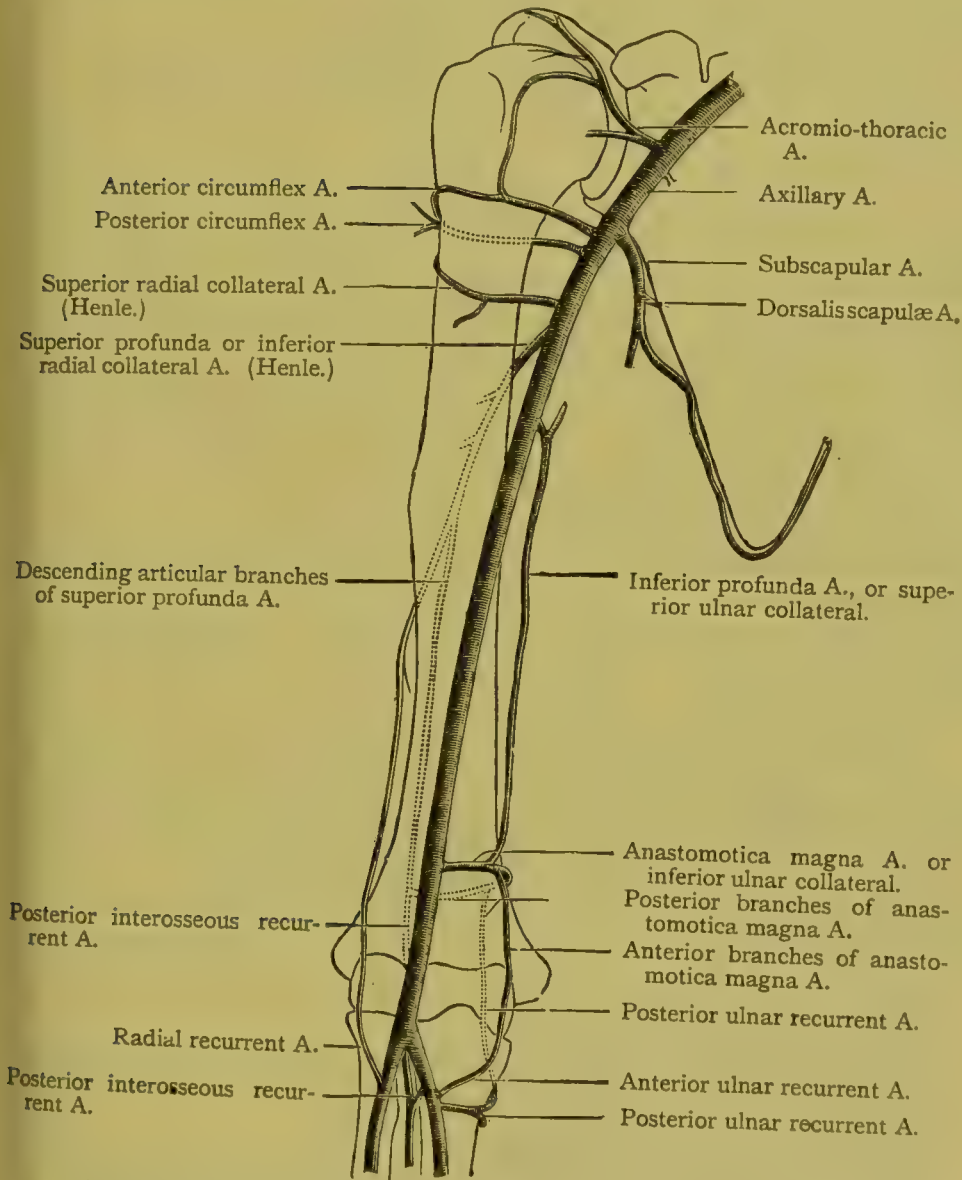
† In one out of every six cases the median nerve lies under the artery: Skey. *loc. supra cit.*, p. 269.

Collateral Circulation.

(a) If the ligature be placed above the superior profunda, the vessels chiefly concerned will be—

Above.		Below.
The subscapular } The circumflex }	with	The superior profunda.

FIG. 41.



Anastomosing branches of axillary and brachial arteries. (Mac Cormac.)

(b) If the ligature be placed below the superior profunda—

Above.		Below.
The superior profunda with	{	The radial recurrent. The posterior ulnar recurrent. The interosseous recurrent. The anastomotica magna.

with a retractor, the median nerve next found and drawn inwards or outwards with a strabismus hook, and the artery defined and sufficiently cleaned, when the ligature is passed from the nerve. In doing this the basilic vein and the venæ comites, which increase in size as they ascend, must be carefully avoided.

I would point out that the brachial artery is by no means so easy a vessel to tie as might be supposed from its superficial position. This is especially the case when the artery is concealed by the median nerve at the point where it is sought, and when its beat is feeble and the vessel itself small and but little distended after repeated hæmorrhage lower down.*

AMPUTATION OF ARM (Figs. 42, 43, and 44).

Indications.—Amongst these are :

1. Accidents, *e.g.*, compound fractures, machinery accidents, &c., which do not admit of any part of the forearm being saved, or of amputation of the elbow. The advisability of amputation in such cases is discussed, once for all, in the chapter on the antiseptic treatment of compound fractures. 2. New growths involving the forearm, and not admitting of extirpation. 3. Disease of the elbow-joint not admitting of excision, or in which this operation has failed (pp. 64, 76). 4. Gunshot injuries of the upper part of the forearm, elbow, and arm not admitting of conservative treatment or excision. So inestimable is the value, even when only partial, of the hand, and so good are the results of conservative treatment and secondary amputation, that the tissues must be almost disorganised for the surgeon to think of primary amputation here.†

* This was so marked in the last of the three cases mentioned at p. 93 that, on my exposing the vessel, several bystanders felt certain that it was not the brachial, but one of its branches.

† Dr. Otis (*loc. supra cit.*, p. 916) thus sums up on the question of conservative surgery, excision, and amputation in gunshot injuries of the elbow-joint:—"The practical conclusions that appear to be deducible from the foregoing investigations are—(1) That in shot wounds in young healthy subjects attended with slight injury of the articular extremities of the bones of the elbow, such as fractures of the olecranon, of the outer condyle, or of the trochlea, without much splintering and without lesion of the important vessels and nerves, it is justifiable in many instances to attempt an expectant conservative treatment, keeping the injured extremity in entire rest, after removing any detached fragments or foreign bodies, in a semi-prone and very flexed position, employing ice or other cold applications. If the inflammatory action becomes intense, the wounds should be freely enlarged, and the joint-cavity freely laid open, and easy escape provided for the altered wound secretions by position and drainage-tubes. The strength should be sustained by a tonic regimen, and when the inflammatory stage has completely abated, and not before, if healing is slow, secondary excision or amputation may be hopefully resorted to. Unless all the favourable conditions mentioned are present at the outset, it would be safer to resort to primary excision or to amputation. (2) In grape-shot comminutions with lesions of the principal vessels or nerves, amputation should be practised immediately after the reception of the

Amongst the special conditions which will have to be considered are the size and character of the projectile, the gravity of the laceration of the soft parts, the amount of longitudinal splintering of the bones, the extent of lesions to the vessels and nerves, and the degree to which conservative measures can be adopted in the absence of hospital facilities or of easy transportation.*

If the surroundings of the surgeon and patient admit of it, attempts will nowadays be made to suture the nerve ends, especially when only one or two of the chief trunks are involved. Whether the old doctrine, that shot-fracture of the humerus with wound of the brachial artery imperatively indicates amputation, is correct must remain uncertain. Dr. Otis (*loc. supra cit.*, p. 674) writes on this point: "I confess that the evidence in the reported cases appears to me insufficiently circumstantial and precise to decide affirmatively this controverted point."

Methods.

i. Skin flaps with circular division of muscles—(a) antero-posterior flaps, (b) lateral flaps.

ii. Transfixion flaps, usually antero-posterior.

iii. Skin and transfixion flaps combined.

iv. Circular. v. Single flap. vi. Teale's method.

i. **Skin Flaps with Circular Division of Muscles.**—

This should be made use of in bulky muscular arms.

(a) **ANTERO-POSTERIOR FLAPS.**—The brachial having been controlled,† the limb supported at a right angle to the body, the surgeon stands outside the right and inside the left limb, with the forefinger and thumb of his left hand marking the site of intended bone section (Fig. 43). He then enters the knife on the side of the limb farthest from him, carries it first down 3, 3½, or 4 inches, according as he is going to make one flap longer than

injury. (3) In severe shot fracture, without extensive lesion of the soft parts, the joint should be freely exposed by a longitudinal posterior incision, and the full extent of the fracture ascertained. Unless there is extraordinary fissuring, the injured joint-ends should then be sawn off as close to the limits of injury as possible, save that the bones of the forearm should be shortened to the same level. If the splintering extends very far, or if there is reason to believe that the humeral vessels are injured though not wounded, the incision should be so modified as to convert the operation into an amputation."

* On this point Dr. Otis writes (*loc. supra cit.*, p. 811): "The surgeons, doubtless, sometimes yielded to what John Bell called 'an argument of necessity as well as of choice, and limbs, that in happier circumstances might have been preserved, had often, in a flying army or a dangerous campaign, to be cut off,' since 'it is less dreadful to be dragged along with a neat amputated stump than with a swollen and fractured limb, where the arteries are in constant danger from the splintered bones.'"

† With an Esmarch's bandage usually; in amputation high up, either the axillary must be controlled by elastic tubing applied by a modification of the method given at p. 121, or the subclavian must be controlled by a reliable assistant, or the vessels secured after the manner given at pp. 120, 124.

the other or not,* next across the limb, with square edges, and up the side nearest to him to the point opposite to that from which the incision started. Then passing the knife under the limb, he marks out a posterior flap, usually somewhat shorter than the anterior. These flaps, consisting of skin and fasciæ, are now dissected up, the muscles cut through at the flap-base with a circular sweep, and the bone sawn through as high as possible. Especial care should be taken here, as in forearm amputations, to divide the nerve-trunks square and high up.† In tying the main arteries, each must be thoroughly separated from its accompanying nerve.

(b) **LATERAL FLAPS.**—This method may be made use of, one flap being cut longer than the other, when the skin is more damaged on one side.

The surgeon, standing as before, marks the site of bone-section by placing his left forefinger and thumb, not now on the two borders of the arm, but on the middle of the anterior and posterior surfaces of the limb. Looking over, he enters his knife at the latter spot, and cuts a well-rounded flap, ending on the middle of the anterior aspect, and then, from this point, without removing the knife, another flap is marked out by a similar incision ending at the middle of the back of the arm. The flaps are then dissected up, and the operation completed as before.

ii. **Transfixion Flaps, usually Antero-posterior** (Fig. 42).—In an arm of moderate size, or in cases where rapidity is required, as in warfare or in cases of double amputation, this method may be made use of. The surgeon, standing as before,‡ and with his left hand marking the flap-base, and lifting up the soft parts in front of the humerus so as to get in front of the brachial vessels, and thus avoid splitting them, sends his knife across the bone and in front of the above vessels, and makes it emerge at a point exactly opposite; he then cuts a well-rounded flap, about 3 inches long, with a quick sawing movement, taking care, after he feels the muscular resistance cease, to carry his knife on a little, so as to cut the skin longer than the muscles, the knife being finally brought out quickly and perpendicularly to the skin. The flap being then lightly raised, without forcible retraction, the knife is passed behind the bone at the base of the wound already made, and a posterior flap cut similar to the anterior, but somewhat shorter. Both flaps are then retracted, any remaining

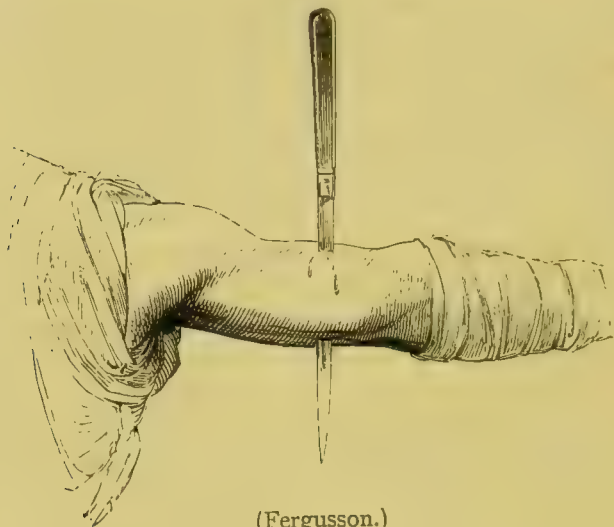
* If the flaps are cut of equal length, the cicatrix will be opposite, and perhaps adherent to, the bone; this is very undesirable, though of less importance in a stump of the upper than of the lower extremity.

† In an amputation which passes through the musculo-spiral groove, great care must be taken to divide completely the nerve lying in this, before the bone is sawn. The depth of this groove varies much. When it is considerable, the nerve may easily escape division and be frayed by the saw, giving rise, if overlooked, to a most painful, bulbous end.

‡ In Fig. 42 the surgeon is supposed to be standing outside the left arm.

muscular fibres divided with circular sweeps of the knife, and the bone exposed a little above the junction of the flaps. The saw is then applied after careful division of the periosteum. The brachial artery will either be found in the posterior flap, or if, as both flaps are made, the soft parts are drawn a little from the humerus, the

FIG. 42.

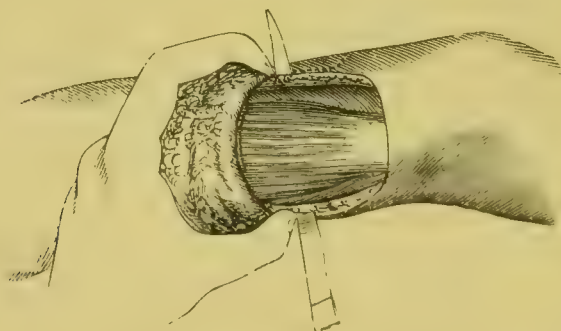


main artery and nerves will be left, and must be cut square with the circular sweeps of the knife.

If it be preferred, lateral flaps can be made by transfixion (Fig. 42), one of course being cut longer than the other if this is rendered desirable by the condition of the soft parts.

iii. **Combined Skin and Transfixion Flaps** (Fig. 43).—This, a very speedy and efficient method, may be made use of:

FIG. 43.

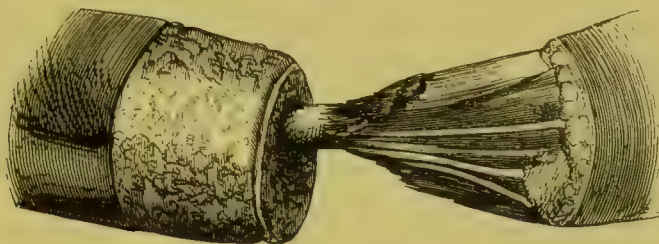


here. An anterior flap of skin and fasciæ, about 3 inches long, having been marked out (p. 98) and dissected up, the bulk of the soft parts behind the bone are drawn a little away from it. the knife passed behind the humerus, and a posterior flap, somewhat shorter, cut by transfixion.

iv. **Circular** (Fig. 44).—Owing to the moderate size of the limb, and its circular shape, this is the place, above all others, where this method can be made use of, especially in limbs which are not very bulky. Whether he make use of it in after-life or not, the student should always practise circular amputation here on the dead subject.

Standing as before, or on the outer side of either limb, the surgeon, with his left hand, draws the skin up strongly, and passes his knife under the arm, then above, and so around it, till, by dropping the point vertically, the back of the knife looks towards him, and the heel rests on the part of the arm nearest to

FIG. 44.



him. A circular sweep is then made round the limb, the completion of this being aided by the assistant in charge of the limb, who should rotate it so as to make the tissues meet the knife. A cuff-like flap of skin and fasciæ* is then raised, for $2\frac{1}{2}$ or 3 inches, with light touches of the knife, these being especially needed along the lines of the intermuscular septa. In a very muscular arm it may be difficult to raise the skin as directed, and it will be sufficient here for an assistant to retract it evenly all round as it is freed by the knife. When the skin has been sufficiently folded back or retracted, the muscles are cut through close to the reflected skin.† The cut muscles are next retracted by the operator's left hand, and the remaining soft parts, with the main vessels and nerves, are severed clean and square.‡ The bone is then freed for $\frac{3}{4}$ inch, and the periosteum, having been divided, is sawn through as high as possible.

v. **Single flap.** This, preferably an anterior, is cut by transfixion, and so arranged, if possible, as not to include the large nerves (Malgaigne).

vi. **Teale's method.** This is, however, expensive of important parts.

Height of Section of the Bone.—If possible, the head of the

* See foot-note, p. 61.

† By some it is advised to cut the biceps rather longer than the rest, owing to its retracting more, as it is not attached to the humerus.

‡ See the remarks (foot-note, p. 99) on the importance of securing thorough and clean division of the musculo-spiral nerve when the amputation passes through the groove.

humerus should always be left *in situ*. This not only leaves a far more shapely stump, but, as pointed out by Farabeuf quoting from Percy, it furnishes a useful point of attachment for an artificial limb, and one well fitted to bear pressure in certain occupations. Farabeuf (*loc. supra cit.*, p. 350) alludes to the necessity of preserving, in amputations high up, some part of the insertion of the pectoralis major in order to counteract the tendency of abduction of the stump.

EXCISION IN CONTINUITY OF THE SHAFT OF THE HUMERUS.

This operation has been especially discussed in reference to gunshot wounds. By the term "excision in continuity," deliberate removal of portions of the shaft of the humerus—*e.g.*, 2–6 inches—the periosteum being preserved as far as possible, is meant; such operations as incision and removal of splinters, operations for necrosis and for pseudo-arthritis, should be excluded.

Dr. Otis* thus writes of this operation:

"I cannot discern that the experience of the war lends any support to the doctrine of the justifiability of operations of this nature except in very exceptional cases. The numerical returns, and the necessarily abbreviated summaries, may appear, at first glance, to represent the results in a favourable light, but a more precise analysis reveals most lamentable conclusions. . . . The mortality rate is nearly double that observed in the cases treated by expectant measures, and more than 12 per cent. higher than the fatality in a larger series of primary amputations in the upper third of the arm. Moreover, in the 477 cases of recovery there were no less than 99 instances in which 'no bony union' was reported, and 65 others recorded as examples of 'false joint.' There were also amongst the cases reported as 'successful' 37 instances of consecutive amputation of the arm. Recourse was had to ulterior exarticulation or amputation in 64 patients, of whom 27 perished.

"Such evidence warrants the assertion that early excision in the continuity of the humerus after injury can seldom be justifiable, a conclusion at which European surgeons had already arrived from the experience of the Schleswig-Holstein and Danish Wars, and which had been confirmed by more recent observations. The coaptation of the resected ends of the bones by silver wires was sometimes practised, with few illustrations of favourable results. Examination of the details of many of the formal primary excisions in the shaft strengthens the impression that they were for the most part unnecessary and injurious."

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 695 *et seq.* In Circular No. 3, p. 223, seven "successful" cases are briefly reported. In one of these, two months after the removal of 3 inches of the shaft (the operation being performed for caries a year after a gunshot injury), bony union had taken place, the functions of the hand and arm were well performed. The patient could lift 8 or 10 lbs., and the arm was still becoming stronger. The bone removed is said to have been completely denuded of its periosteum in its entire circumference, this membrane being probably thickened.

Causes of Failure after Excision of the Humerus in Continuity.—Amongst these are :

1. Osteo-myelitis and pyæmia. 2. Secondary hæmorrhage.
3. Secondary necrosis. 4. Non-union, leading to a limb which dangles* or is flail-like, and is more or less useless in spite of a support.

While excision in continuity of the humerus is to be condemned as a primary operation, and while the same operation performed secondarily for necrosis may lead to a limb which is of little use without an artificial support, the following case of Dr. Macewen's (*Annals of Surgery*, vol. vi. No. 4, p. 301) shows what ingenuity and perseverance may effect in such cases, and proves that detached portions of bone deprived of their periosteum are capable of living and growing after transplantation :

A boy, aged two, had complete † necrosis of the shaft of his right humerus after suppurative periostitis. The necrosed bone was removed about nine weeks after the onset of the periostitis, leaving the layer of granulations covering the periosteum intact, and forming a tube, which was kept patent by dressings suitably inserted until the whole space had granulated up. No bone grew from the periosteum, except a small part next the proximal epiphysis, where, at the outset, the periosteum was found covered by plaques of adherent osseous tissue. From the whole of the remainder there was no osseous deposition, the result being a flail-like arm. Fifteen months subsequently he returned to the Glasgow Royal Infirmary, his parents desiring that the arm should be removed, it being worse than useless, inasmuch as he required the other hand and arm to look after the flail-like one, which was constantly dangling in the way. The condition of the arm was as follows :—The bone had not increased in length since he left the hospital. When the limb was allowed to hang by the side, the measurement, from the tip of the acromion process to the distal extremity of the humeral shaft, was nearly two inches. The proximal fragment was conical, and tapering from the rounded head to a narrow spike-like extremity. From this to the condyles there was a complete absence of bone, there being nothing but soft tissues in the gap. The muscular power was good, but when he attempted to raise his arm a contraction of the muscles took place, the condyles being drawn towards the proximal extremity, while some fibres of the deltoid raised the spike-like process of the upper portion, causing it to project, as if about to penetrate the skin. Here the action ceased, the soft parts in the gap appearing like a rope during the muscular contraction. He could not raise his forearm to his breast, the lever and fulcrum needed being wanting. It was determined to supply these by transplantation from other human bones. In the wards there were numerous cases of marked anterior tibial curves, from which wedges of bone had to be removed, and these were used as transplants. An incision was made into the upper third of the humerus, exposing the head of the bone. Its extremity, for fully $\frac{1}{2}$ inch, was found to be cartilaginous. The cartilaginous spike-like process

* There is a good illustration of this result in Fig. 506, *loc. supra cit.*, p. 682. Further details are needed of the amount of use made of, and the ultimate advantage accruing from, the ingenious apparatus of Dr. Hudson, which was supplied to many of these cases.

† Dr. Macewen points out that it is probable that in the outset of this case the nutrient artery of the humerus was occluded or separated in the intensity of the suppurating process. The periosteum which remained, not only did not produce bone, but fifteen months later appeared to have been completely absorbed.

was removed, leaving there a portion of bone, which measured $1\frac{3}{4}$ inch from the tip of the acromion. From this point a sulcus, about 2 inches long, was made, downwards, between the muscles. The former presence of bone was nowhere indicated, and there was no vestige of periosteum, and the sole guide as to the correct position into which the transplant was placed was an anatomical one.* Two wedges of bone were then removed from the tibia of a patient, aged six, affected with anterior curves. The base of these osseous wedges consisted of the anterior portion of the tibia, along with its periosteum. After removal they were cut into minute fragments with the chisel, quite irrespective of the periosteum. The bulk of the fragments had no periosteum adhering to them, they having been taken from the interior of the bone. They were then deposited in the muscular sulcus in the boy's arm, and the tissues drawn over them and carefully adjusted. The wound healed without pus production.† Two months after, a portion of bone, 1 inch in length, and $\frac{3}{4}$ inch in thickness, was found firmly attached to the upper fragment of the humerus. In moving the finger from the head of the bone towards the graft, the latter could be easily distinguished by the sudden increase in the breadth. Now, instead of the former sharp spike, the upper fragment ended obtusely. Two other wedges of bone, of larger size than the first, were similarly dealt with, and inserted two months after the first. These filled up the gap in the arm to the extent of $4\frac{1}{4}$ inches, the arm then measuring 6 inches in length. Soon the utility of the arm was greatly restored.

Seven years afterwards the patient was seen and examined. The shaft of the humerus was found to have increased in length by $1\frac{3}{4}$ inch, being now $7\frac{3}{4}$ inches, it had increased in circumference to a marked extent, and had assumed a somewhat irregular shape. The patient could use his arm for a great many purposes—taking his food, adjusting his clothes, and in many games.

In some remarks on this case, Dr. Macewen advances the following arguments against the supposition that the new bone grew from old periosteum:—(1) If any of this had existed and possessed osteogenic power, it had ample time to reveal itself by osseous growth during the fifteen months which had elapsed between the removal of the dead bone and the transplantation of the new. (2) In opening the sulcus between the muscles for the reception of the transplants no periosteum or anything like fibrous membrane was seen. (3) The growth of the bone was at first only commensurate with the insertion of the transplants, there being no indication of any osseous growth in the vicinity of these which might have arisen from the supposed stimulation of the periosteum. (4) The solid humerus still retains the irregularities of shape which the transplants were permitted to assume in the tissues.

OPERATIONS ON MUSCULO-SPIRAL NERVE.

Relief from Compression.—This is a lesion to which this nerve is, owing to its close connection with the shaft of the humerus, occasionally liable after fracture of that bone—viz., compression by callus.‡ M. Ollier§ many years ago recorded a case of this kind successfully treated by surgery.

* *I.e.*, the only guide was by recognising the relative positions which the muscles ought to occupy towards the humerus.

† The importance of this statement, and its effect upon the very happy result of the case, will not escape the reader.

‡ The occasional abundance of this callus may, perhaps, be in part accounted for by the great thickness of the periosteum of the humerus.

§ *Syd. Soc. Bien. Retr.*, 1865, 1866, p. 294; *Gaz. Hebd.*, 1865, p. 515.

A man, aged twenty-two, had suffered a compound fracture of the right humerus, through the musculo-spiral groove. Four months later, the fracture having firmly united, the extensors of the wrist and fingers were completely paralysed, and sensibility along the course of the radial was much diminished. The integrity of the functions of the triceps seemed to show that the lesion must be seated below the commencement at the musculo-spiral groove, where the branches to that muscle are given off. M. Ollier concluded that the nerve was compressed either by one of the fragments or by exuberant callus. Prolonged treatment directed towards the removal of the callus having failed, the patient was submitted to operation. An incision having been made in the presumed direction of the nerve, so as to expose it in the external intermuscular septum, it was found by tracing a branch upwards. A gutter was next cut with chisel and mallet for $1\frac{1}{2}$ inch through the callus, this step exposing the nerve, swollen and hypertrophied in its lower part, and above, strangled (as if by a ligature) by a point of bone apparently belonging to the lower fragment. This point being cut off, and a probe passed behind the nerve to secure its complete isolation, the nerve was then followed for $\frac{1}{2}$ inch above and below the bony canal, so as to ensure its liberation, and, in order to obviate any reproduction of bone, the periosteum was removed all round. The nerve was not disturbed from its gutter for fear of contusing or stretching it. The wound healed rapidly. From the sixth day the patient experienced some pricking sensations on the back and outer part of the forearm, and sensibility began to increase in the thumb and forefinger. On the twentieth day he could raise his hand a little by voluntary efforts, and when he left the hospital, six months and a half after the operation, he insisted on going back to his work in the fields.

Similar cases have been recorded by M. Trélat, by M. Tillaux (*Traité d'Anatomie Topographique*, p. 511), and by Mr. Puzey,* of Liverpool (*Brit. Med. Journ.*, vol. ii. 1889, p. 309), in each case with a successful result. The nerve was found either between the two heads of the triceps, or, by following it up from its site between the brachialis anticus and supinator longus. In Mr. Puzey's case, it had been noted, three months after the fracture, that there was rather an excess of callus present.

Suture.—Mr. Lucas (*Guy's Hosp. Repts.*, xlv. p. 1) records two cases of division of this nerve by stabs. In one case, a lad aged sixteen, the axillary vein and superior profunda were wounded as well, the musculo-spiral nerve was divided, and its lower part torn and notched. The damaged part was cut away, and the ends united by two catgut sutures. Complete recovery followed, about three months after the injury. The other case came under care about two months after the injury, the scar being 5 inches from the acromion, opposite the insertion of the deltoid, rather behind the line of the humerus on the outer side. On laying bare the nerve it was found that there was a high division into radial and posterior interosseous, the latter being completely severed just after

* This surgeon also relates (*Brit. Med. Journ.*, vol. i, 1885, p. 979) a case in which he successfully operated, six months after the injury, in order to set free the ulnar nerve which had been drawn into the callus uniting a compound fracture of the bones of the forearm.

its origin. The musculo-spiral just before its division, and the radial at its commencement, were involved in dense scar tissue. They "were relieved" from this, and the ends of the posterior interosseous being resected, were united by fine catgut. The arm gradually improved with three months' galvanism, and a complete cure followed.

CHAPTER VI.

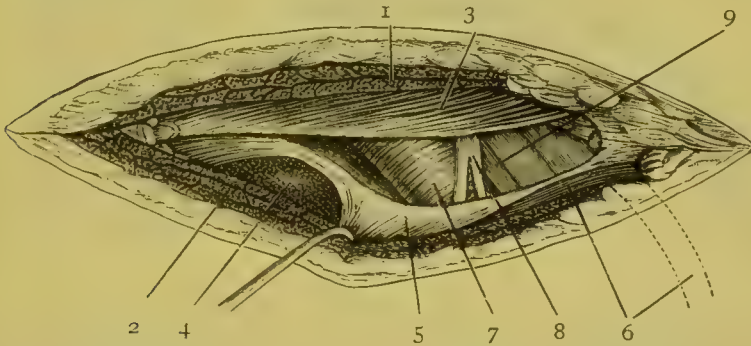
OPERATIONS ON THE AXILLA AND SHOULDER.

LIGATURE OF AXILLARY ARTERY (Figs. 45, 46, 47, and 48).

Indications.

1. Wound of the artery.* 2. Aneurism of the brachial high up.† More rarely still—3. As a distal operation for aneurism of the subclavian. 4. Very occasionally, as the old operation after rupture of the axillary artery in shoulder dislocations (p. 113). 5. Very occasionally, as the old operation for axillary aneurism (p. 113). 6. For hæmorrhage from malignant disease in the axilla.

FIG. 45.



Parts concerned in ligature of the first part of the (left) axillary artery. 1 and 2. Cut edges of the clavicular attachment of the pectoralis major. 3. Subclavius. 4. Axillary vein. 5. Sheath of subclavius, which, depressed, has partly concealed 6 (the cephalic vein), seen to the right. 7. Axillary artery. 8. Nerve to pectoralis major. 9. Cords of brachial plexus. (Farabeuf.)

These cases are extremely rare, but a good instance, and one showing the difficulty of meeting them, was published by Sir W. Savory (*Med. Chir. Trans.*, vol. lxix. p. 157).

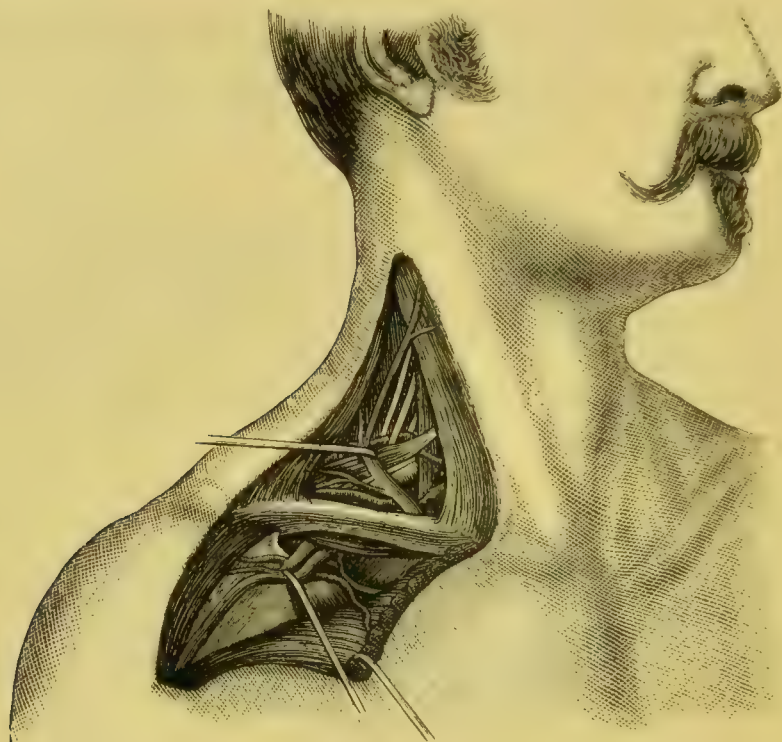
* In some wounds of the artery, the surrounding parts—*c.g.*, veins and nerves—may be so injured, that the vitality of the limb is impaired beyond what ligature and nerve-suture can do, and the advisability of amputating at the shoulder-joint must be considered.

† Dr. Holt (*Amer. Journ. Med. Sci.*, April 1882) mentions a case (p. 385) of aneurism of the right brachial at its upper third; ligature of the axillary in its lower third; secondary hæmorrhage; ligature of the axillary artery in its upper third; cure.

Operations.—Ligature of the first and the third parts of the artery will be first described, and then the old operation.

i. **Ligature of the First Part** (Figs. 45, 46, and 47).—This operation is very rarely performed on the living subject. Owing to the depth of the vessel here, its most important and intimate surroundings, and the risk of secondary hæmorrhage from the vessels which lie so close to the knot, ligature of the third part of

FIG. 46.



Relations of subclavian and axillary arteries. The Sterno-mastoid, Trapezius, Omo-hyoid are seen above. The blunt hook draws outwards the external jugular, which is falling into the subclavian vein. The artery is seen emerging from beneath the scalenus anticus, below the nerves. Two arterial branches pass outwards, the one close to the clavicle, the supra-scapular; the other, higher up, the posterior scapular, or transverse cervical. The Deltoid, a blunt hook depressing the clavicular part of the pectoralis major, the coracoid process, to which the lesser pectoral is attached, and the lower part of the costo-coracoid membrane are seen below. A blunt hook also depresses the cephalic vein, and exposes the artery, which here gives off its acromio-thoracic branch. (Farabeuf.)

the subclavian is preferred if ligature be required for axillary aneurism. On the dead subject the student should always take the opportunity of tying the first part of the axillary, as it is an excellent test of anatomical knowledge and practical skill.

LINE.—From the centre of the clavicle (with the arm drawn from the side) to the inner margin of the coraco-brachialis.

GUIDE.—The above line, and the inner margin of the coraco-brachialis.

RELATIONS :—

IN FRONT.

Skin ; fasciæ ; fibres of platysma. Supra-clavicular nerve.
 Pectoralis major (with muscular branches).
 Costo-coracoid membrane.
 Cephalic vein. Acromio-thoracic vessels.

OUTSIDE.

Outer and inner cords
 of brachial plexus.

Axillary artery,
 first part.

INSIDE.

Axillary vein.

BEHIND.

First digitation of serratus magnus.
 First intercostal space and muscle.
 Posterior thoracic nerve.

Collateral Circulation (Fig. 41):

(a) If the artery be tied in its first part, and the ligature be placed above the acromio-thoracic, the vessels concerned will be the same as those which carry on the blood-supply after ligature of the third part of the subclavian (*q.v.*).

(b) If the artery be tied in its third part and the ligature be placed below the circumflex arteries, the anastomosing vessels will be the same as after ligature of the brachial above the superior profunda (p. 95).

(c) If the artery be tied in its third part, and the ligature be placed between the sub-scapular and circumflex arteries, the chief vessels concerned are :

ABOVE.

The supra-scapular }
 The acromio-thoracic }

with The posterior circumflex.

BELOW.

(d) If in tying the third part of the artery the ligature be placed above the sub-scapular, the anastomoses are more numerous—viz., in addition to those just given :

ABOVE.

The supra-scapular }
 The posterior scapular }

with The sub-scapular.

BELOW.

Operation.—The vessel may be secured in the following ways. The first two are recommended.

A. By a curved incision below the clavicle. This gives the necessary room, but has the disadvantage of dividing the pectoralis major and its large muscular branches.

B. By an incision in the interval between the pectoralis major and deltoid (Fig. 47). This method scarcely gives sufficient room, especially if the parts are displaced by effused blood, &c., and it is well to supplement the incision in the interval by one partly detaching the pectoralis from the clavicle (p. 111). While this plan involves less hæmorrhage from the pectoralis major, care must be taken to avoid the cephalic vein and acromio-thoracic branches which lie in this interval. This end is best secured, whichever method is adopted, by going down on the artery as

close to the clavicle as possible, the sheath of the subclavius being opened, and some of its fibres detached, if needful.

C. By an incision in the line of the artery—viz., one $3\frac{1}{2}$ –4 inches long, starting from just outside the centre of the clavicle, and passing downwards and outwards. This has the disadvantage of cutting the muscular branches to the pectoralis major, and gives less space than the first two.

A. The limb being at first abducted, the surgeon, standing between it and the body, which is brought to the edge of the table, makes a curved incision, with its convexity downwards and about $\frac{1}{2}$ inch from the clavicle, reaching from just outside the

FIG. 47.



Part of the clavicular origin of the pectoralis major has been turned inwards with the flap of skin. The costo-coracoid membrane is seen cut above and below the artery, in the latter case being turned down over the pectoralis minor.

The cephalic vein runs up along the inner edge of the deltoid; a second vein lies on the cords of the brachial plexus above the artery, while others cross the upper part of the wound.

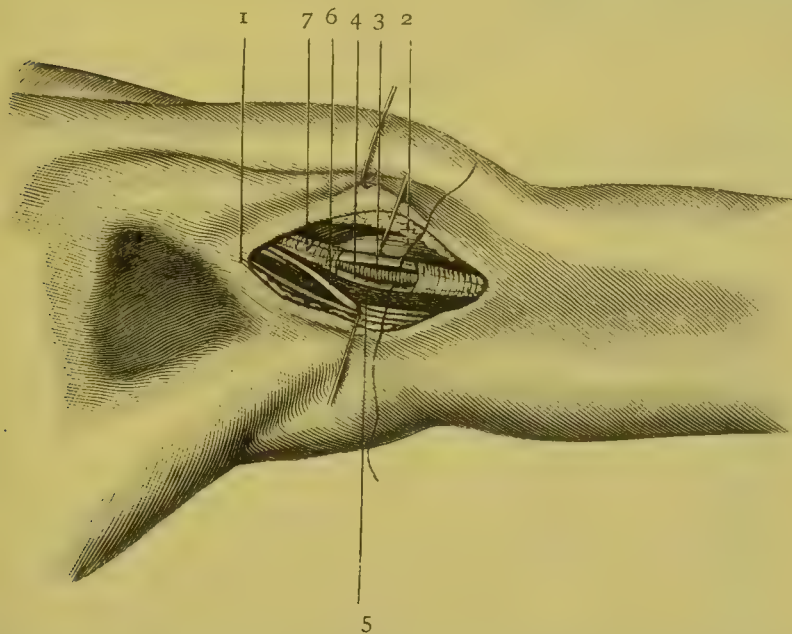
sterno-clavicular joint to the coracoid process, the knife being used lightly at the outer end of the incision, so as to avoid wounding the cephalic vein and branches of the acromio-thoracic vessels. The clavicular origin of the pectoralis major is then divided in the whole extent of the wound, and any muscular branches which require it tied or twisted at once. The cellular tissue beneath the muscle being next explored with the tip of the finger and director, the upper border of the pectoralis minor is defined, and this muscle drawn downwards. The costo-coracoid membrane must next be most carefully torn through close to the coracoid process, which is a good guide, by means of a fine-pointed steel director, the cephalic vein and acromio-thoracic vessels being most scrupulously avoided. The wound all this time must be kept dry.

and, if needful, a large laryngeal mirror or an electric lamp may be usefully employed in throwing light into the bottom of the deep wound. The pulsation of the artery being felt for in the living, and its flattened cord-like feel made out in the dead subject, the sheath is exposed,* and the vessel itself carefully cleaned and separated from the vein, which lies below and in front, and from the brachial cords, which are above the artery. The needle should be passed from below so as to avoid the vein.†

B. By an incision made between the pectoralis major and deltoid (Fig. 47).

The limb and the surgeon being in the same position as in the operation just given, an incision is made obliquely downwards and

FIG. 48.



Ligature of third part of (left) axillary artery. 1. Axilla at the junction of its middle and anterior thirds. 2. Coraco-brachialis, and above it biceps. 3. Median nerve. 4. Axillary artery. 5. Axillary vein. 6. Internal cutaneous nerve. 7. Ulnar nerve hooked downwards.

outwards between the above muscles commencing at the clavicle opposite to the coracoid process. Care being taken to avoid the cephalic vein and branches of the acromio-thoracic vessels, the muscles are separated, and, to gain more room,‡ a transverse incision is made running inwards along the lower border of the clavicle, and detaching as much as is required of the clavicular origin of the pectoralis major. This flap can be turned inwards

* The parts may now be advantageously relaxed by adducting the arm.

† The patient must be prepared for probably weakened or limited use of his limb for some time, at least, after the main arterial trunk has been ligatured.

‡ This step is advocated by Mr. Rivington (*Brit. Med. Journal*, 1885, vol. i. p. 1040).

and downwards without any interference with the nerve-supply of the muscle, and, owing to its high division, less hæmorrhage is met with by this method. The deltoid being strongly drawn outwards with a retractor, the upper border of the pectoralis minor is defined, and the operation completed as in the account already given, the parts being relaxed at this stage by adduction of the arm.

ii. Ligature of the Third Part of the Axillary Artery (Fig. 48).

LINE.—From the centre of the clavicle with the arm drawn from the side to the inner margin of the coraco-brachialis.

GUIDE.—The above line. A line drawn from the junction of the middle and anterior thirds of the axilla, along the inner border of the coraco-brachialis.

RELATIONS:—

IN FRONT.

Skin; fasciæ.

Pectoralis major.

OUTSIDE.

Musculo-cutaneous, median. Inner border of coraco-brachialis.

Axillary artery, third part.

INSIDE.

Internal cutaneous; ulnar. Axillary vein or venæ comites.

BEHIND.

Sub-scapularis.

Latissimus dorsi.

Teres major.

Circumflex. Musculo-spiral.

Operation (Fig. 48). — This resembles somewhat that for ligature of the brachial in the middle of the arm. As with the brachial, so with the axillary here; though the vessel is comparatively superficial, it is not an easy one to hit off at once, owing to the numerous surrounding nerves, which may resemble the artery closely, especially if blood-stained.

The axilla being shaved, the arm being extended from the side and rotated slightly outwards (not too forcibly, as this will alter the relations), the surgeon, sitting between the limb and the trunk, makes an incision, $2\frac{1}{2}$ or 3 inches long, at the junction of the anterior and middle thirds of the space along the inner border of the coraco-brachialis (Fig. 48). The incision may be begun above or below, as is most convenient. Skin and fasciæ being divided, and the point of a director used more deeply, the coraco-brachialis is identified, and the axillary vein and the median nerve are distinguished from the artery, the former drawn inwards and the latter, together with the coraco-brachialis, outwards.* The

* Farabeuf (*loc. supra cit.*, p. 44), gives the following directions for making sure of the artery: 1. Make an incision running just behind the anterior wall of the axilla. Identify the coraco-brachialis by opening its sheath. Draw it outwards, and with the finger of the left hand sunk in the wound, depress the whole bundle of vessels and nerves. The first cord which escapes upwards, when the finger is withdrawn a little, is free, perforating no muscles, this is the median. Isolate it and have it drawn outwards with the coraco-brachialis. The second large cord uncovered by withdrawing the first is the artery.

artery is then made sure of, cleaned, and the needle passed from within outwards, the neighbourhood of any large branch, such as the sub-scapular or the circumflex, being avoided, and the needle being kept very close to the artery. Instead of one axillary vein, two *venæ comites*, and the basilic as well, may be present.

iii. **Old Operation of Ligature of Axillary Artery for Some Cases of Axillary Aneurism and Injured Axillary Artery.**—This method may be made use of in the following instances :

1. Where pressure has failed in the above cases. 2. Where pressure is unsuitable owing to the rapid increase, and large size, of the aneurism; the condition of the parts over it; or the inability of the patient to bear pain. 3. Where owing to the displacement of the clavicle, ligature of the subclavian is not likely to be practicable, or where the condition of the coverings of the aneurism is such that this step, even if carried out, will not avert suppuration, sloughing, &c.

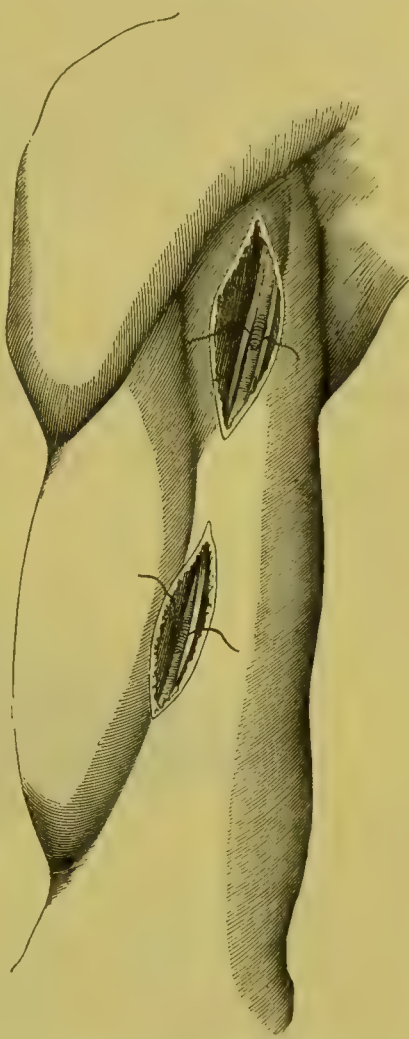
Prof. Syme (*Observations in Clinical Surgery*, p. 140 *et seq*), holding that the old method would certainly remedy cases not amenable to ligature of the subclavian, and that even in cases where the latter is practicable the former might be preferable, made use of it in three cases.

In the first case, the skin in the neighbourhood of the shoulder-joint was dusky red and vesicating, and the patient beginning to wander in his mind. In the third, after the operation, delirium tremens set in, with excessive suppuration and sloughing of the tissues of the limb. All three recovered, though fifty, forty-seven and about fifty respectively.

The following is the account of the operation in Prof. Syme's words (*loc. supra cit.*, p. 148):

I made an incision along the outer edge of the sterno-mastoid through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed

FIG. 49.



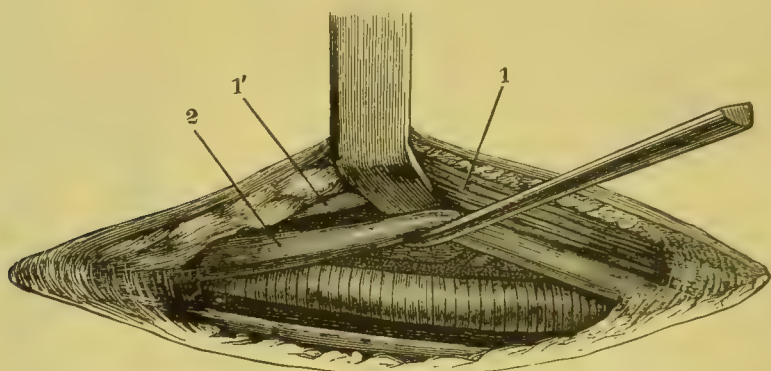
The lower incision shows ligature of the brachial in the middle of the arm (p. 93). The artery is immediately internal to the inner edge of the biceps, the median nerve having crossed the vessel rather high up.

In the ligature of the third part of the axillary, the artery, with the median nerve on the outer and the ulnar on the inner side, lies just internal to the coraco-brachialis. In both the operations too much of the nerves is shown.

down to the situation where the subclavian lies upon the first rib. I then opened the tumour,* when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly 7 pounds of coagulated blood. The axillary artery appeared to have been torn across, and, as the lower orifice still bled freely, I tied it in the first instance, next cut through the lesser pectoral muscle close up to the clavicle, and, holding the upper end of the vessel between my finger and thumb, passed an aneurism needle so as to apply a ligature about $\frac{1}{2}$ inch above the orifice. The extreme elevation of the clavicle, which rendered the artery so inaccessible from above, of course facilitated this procedure from below. Everything went on favourably afterwards.

Sir J. Paget and Mr. Callender (*St. Bartholomew's Hosp. Repts.*, vol. ii.) made a —|—shaped incision, cutting parallel with the

FIG. 50.



Parts seen in ligature of the third part of the (left) axillary artery, dissected. The flat retractor raises (1) the coraco-brachialis, the first guide, together with (1') the musculo-cutaneous nerve contained in it. The blunt hook draws aside (2) the median nerve, the second guide. Below the axillary artery is seen the small internal cutaneous nerve, which, like the axillary vein and the other large nerve trunks, is often not seen. Just above the artery, in the depth of the wound, is seen one of the venæ comites. (Farabeuf.)

lower margin of the pectoralis major, and a second at right angles to the first straight up through the whole width of the pectoralis major.

A short space may be allotted here to that most important accident which has happened to so many surgeons—viz., rupture of the axillary artery while dislocations of the shoulder are being reduced. Of late years the great fatality which the old operation has met with here has been pointed out. Dr. Stimson (*Ann. of Surg.*, Nov. 1885) draws the following conclusions from forty-four cases:—"Conservative treatment—viz., complete rest with direct pressure—may properly be tried at first, especially if the tumour is small, recent, and not increasing, but should not be

* In one of his cases, while laying open the cavity, Prof. Syme had to avoid the radial artery, which ran over the surface of the sac.

prolonged if the symptoms do not promptly yield; and, secondly, in case of resort to operation, ligature of the subclavian or disarticulation at the shoulder is to be preferred to incision of the sac and double ligature of the artery." Of seven cases of double ligature of the artery, all were fatal. Of fourteen of ligature of the subclavian, five recovered. Without operation, thirteen died, six recovered. Of four cases of amputation at the shoulder only one recovered. Repeated puncture is always fatal. Körte, of Berlin (*Arch. f. klin. Chir.*, Bd. xxvii. Hft. 3, quoted by Dr. Stimson), is of opinion that in many cases the injury to the artery is caused at the time of the accident, but hæmorrhage does not come on till after reduction is brought about, as the vessel is compressed by the head of the bone. As to the exact cause of the injury to the vessel when it takes place at the time of the reduction, it is probable that some special condition exists to account for it, as so many old dislocations are reduced with much force, used with impunity—*e.g.*, atheroma; adhesion of the artery to the head of the bone; too great or misapplied force in reduction—*viz.*, use of the boot, in elevation; projection of a fragment or a spicule of bone. It is usually the axillary artery, or one of its branches, which gives way; much more rarely (four out of forty-four cases), the axillary vein.

AMPUTATION AT THE SHOULDER-JOINT.

Indications.

i. Compound comminuted fractures—*e.g.*, railway and machinery accidents.

ii. Gunshot injuries.—Amputation here is divided by Dr. Otis* into (1) Primary, or before the third day; (2) Intermediary, or cases in which the operation was performed between the third and the thirtieth days; and (3) Secondary, in which the operation was performed later than the thirtieth day.

(1) Primary.—The mortality here was 24 per cent. The indications for amputation so soon after the injury are chiefly—(a) A limb torn off partially, but too high to admit of any other amputation; (b) Severe comminuted fracture of the upper end of the humerus, with extensive injury to the vessels and nerves; (c) Such a fracture high up, with severe splintering extending down below the insertions of the pectoralis major and the latissimus dorsi.†

(2) Intermediary.—The mortality here, 45 per cent., was nearly double that of the primary. This seems to have been brought about largely by the fact that the operation was now performed through soft parts, the seat, at this time, of unhealthy inflammation, and thus prone to lead to secondary hæmorrhage, pyæmia, sloughing, &c.

(3) Secondary.—The causes for this deferred operation were

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 613 *et seq.*

† In some of these the adoption of the Furneaux-Jordan method (p. 131) might lead to diminished loss of blood.

chiefly hæmorrhage, gangrene, profuse suppuration, hopeless disease of the humerus, sometimes with consecutive implication of the joint, chronic osteo-myelitis, or necrosis of the entire humerus. The mortality was 28 per cent. From the above it is evident that the necessary examination should be made, and the operation performed, as soon after the injury as possible, consistent with the state of the patient, the difference between operating in sound and diseased parts, and the neighbourhood of the joint to the chest, if a septic condition of the wound sets in, being borne in mind.

iii. New growths.—If these involve the scapula or its processes, the upper extremity should be removed by the method of inter-scapulo-thoracic amputation (p. 153).*

iv. Disease of the shoulder-joint unsuited for, or persisting after failure of, excision.

v. For osteo-myelitis and necrosis of humerus resisting other treatment, or complicated with early blood-poisoning.

vi. For rapidly spreading gangrene or gangrenous cellulitis with threatening septicæmia.

Mr. Heath (*Clin. Soc. Trans.*, vol. xiv. p. 114) has recorded such a case in which this amputation was needed to save life.

A nurse had pricked her finger deeply with a pin hidden in some of the clothes of a lady who had died of virulent puerperal septicæmia; gangrenous cellulitis rapidly set in, and extended in spite of incisions: on the sixth day the gangrene appeared to be arrested in the forearm, though there was a blush of advancing mischief up the arm. In the afternoon of the same day sudden extension took place, and Mr. Heath removed the arm at the shoulder-joint, the patient ultimately making a good recovery.

The operation chosen was by outer and inner flaps, the former giving a fairly healthy flap of deltoid, the latter having to be cut very short owing to the infiltration of the axilla. The dressings became offensive, but the stump healed well.

vii. Amputation at the shoulder-joint may be called for in the following cases of aneurism:—

A. In some cases of subclavian aneurism where other means have failed or are impracticable; where the aneurism is rapidly increasing; where the pain is constant and agonising; and where the limb is threatening to become gangrenous. While the principle of this operation appears to be physiologically sound—*i.e.*, to enable distal ligature to be performed on the face of the stump, and that, by removal of the limb, the amount of blood passing through the aneurism may be diminished—the results hitherto have not been very successful.

Thus, in Prof. Spence's† case, a man aged thirty-three, with a subclavian aneurism, probably encroaching on the second, if not the first, part of the artery, with excruciating pain and threatening gangrene, amputation at the shoulder-joint

* The question of the possibility of saving the limb and removing the growth by excision of the head of the humerus is considered at p. 135.

† *Med.-Chir. Trans.*, vol. lii. p. 306.

was followed by diminution in the pulsation and size of the sac, but with little formation of coagula. Death took place four years afterwards, probably from extension of the aneurism to the innominate and aorta. In this case the operation, though it had but little effect in consolidating the sac, undoubtedly prolonged life, as gangrene was threatening, and the second part of the artery was almost certainly affected, thus rendering the case a most unfavourable one. In Mr. Holden's* case the patient was almost *in extremis*, and the sac gave way. In Mr. H. Smith's† case an intra-thoracic portion of the aneurism also ruptured, there being no evidence as to benefit or otherwise. In Mr. Heath's‡ case (the aneurism being perhaps traumatic in origin, and of the false circumscribed kind) the effect on the aneurism was so transient as to be practically *nil*. Two months after the amputation, as the aneurism continued to increase in size, Mr. Heath introduced into the sac three pairs of fine sewing-needles, making each pair cross within the sac. Considerable clotting took place around the needles, which were withdrawn on the fifth day. The aneurism gradually became solid, but the patient sank soon after from bronchitis. Mr. Heath concluded that amputation at the shoulder-joint for aneurism is not a satisfactory proceeding, but the majority of surgeons present were in favour of further trials of this mode of treatment if it could be resorted to early.

B. With the same objects in view, amputation at the shoulder-joint may be required in some cases of axillary aneurism complicated with extension of the sac upwards, much elevation of the shoulder, conditions which may render compression or ligature of the subclavian impossible, removal of the limb being additionally called for if agonising pain or threatening gangrene is present.

Prof. Syme (*Med.-Chir. Trans.*, vol. xliii. p. 139) briefly alludes to two such successful cases, in one of which gangrene was threatening: "In a case of axillary aneurism in a gentleman of about fifty-two years of age, where ligature was prevented by intense inflammation of the arm, rapidly running on to gangrene, I performed amputation at the shoulder-joint, cutting through the sloughy sides of the aneurism and tying the artery where it lay within the sac."

C. In some cases of inflamed axillary aneurism threatening suppuration, Sir J. E. Erichsen (*Surg.*, vol. ii. p. 217) points out that the question of this amputation may arise. As the old operation of opening the sac, turning out the clots, and securing the vessel above and below is impossible, owing to the fact that the coats of the vessel, now softened, will not hold a ligature, two courses only are open to the surgeon—viz., ligature of the third part of the subclavian, or amputation at the shoulder-joint. While the former may be followed when the aneurism is moderate in size and when there is no evidence of threatening gangrene, amputation must be resorted to when less favourable conditions are present.

If hæmorrhage occur from an inflamed axillary aneurism which has ruptured after the subclavian has been already tied, the same

* *St. Barthol. Hosp. Reports*, vol. xiii.

† Quoted by Mr. Heath, *loc. infra cit.*

‡ In a paper brought before the Medico-Chirurgical Society (*Trans.*, vol. lxiii. p. 65). For the discussion on this, see *Lancet*, 1880, vol. i. p. 169; *Brit. Med. Journ.*, 1880, vol. i. p. 205.

writer, of the two courses now open—viz., either to open the sac and try and include the bleeding spot between two ligatures, or to amputate at the shoulder-joint—strongly advises the latter.

The coats of the artery “in the immediate vicinity of the sac could not, in accordance with what we know to be almost universally the case in spontaneous aneurisms of large size or old standing, be expected to be in anything like a sound, firm state, and would almost certainly give way under pressure of the noose; or the vessel might have undergone fusiform dilatation, as is common in this situation, before giving rise to the circumscribed false aneurism, in which case it would be impossible to surround it by a ligature; or, again, the sub-scapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these the danger of the patient would be considerably increased by the irritation and inflammation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurism, and much valuable time would be lost in what must be a fruitless operation, at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus to remove the whole disease at once.”

D. In the words of Sir J. E. Erichsen,* “there is another form of axillary aneurism that requires immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not; it is the case of diffuse aneurism of the arm-pit, with threatened or actual gangrene of the limb.”

Different Methods.—Of the thirty-six different methods which have been enumerated, most will be found to differ in some unimportant detail. Five methods will be described here, which will be found sufficient, if modified when needful, for all cases. The circumstances under which this amputation is performed do not admit of any one definite method being followed. Thus, after a railway accident or gunshot injury, the soft parts will be destroyed on at least one surface. In amputating for malignant disease, skin flaps must be made use of, transfixion being usually inadmissible, as the muscles should be cut as short and as close as possible to their upper attachments, to minimise the risk of extension and recurrence. Instead of remembering the length and size of differently named flaps, the surgeon will have to be familiar with the anatomy of the parts, the position of the vessels, and the best means of meeting hæmorrhage.

The joint is so well covered that sufficient flaps can† nearly

* *Loc. supra cit.*, p. 218.

† In some cases of gunshot injury it is necessary to get the chief flap from the axillary region, and to bring this up and unite it to the cut margin of skin over the acromion.

always be provided, while the blood-supply is so abundant that sloughing very rarely occurs, and even if it do so, from the results of injury or hospital gangrene, the tissues of the chest will come forward sufficiently to close the wound. While the cavity of the axilla favours exit of discharges below, the abundance of cellular tissue opened up favours diffuse inflammation, and calls for adequate drainage.*

The following methods will be described here: in the first two, skin flaps are made; in the others (save in the Furneaux-Jordan method), transfixion is made use of, in part at least.

In all cases of doubt, as after injury, the condition of the bone, and, if needful, that of the vessels and nerves, should be first cleared up by a free incision as if for excision (Figs. 54, 55 and 56, pp. 124 and 125).

- | | |
|--|----------------------------------|
| i. By lateral skin flaps. The oval, or <i>en raquette</i> methods. | iv. Superior or deltoid flap. |
| ii. Spence's method. | v. Anterior and posterior flaps. |
| iii. Superior and inferior flaps. | vi. Furneaux-Jordan method. |

While the most rapid methods are those of superior and inferior (Figs. 60 and 61), or anterior and posterior flaps (Fig. 62), in each case cut by transfixion, these require the presence of an assistant who can be thoroughly relied upon to seize the artery just before it is cut. Where there is time, and where the soft parts admit of it, one of the methods with a vertical incision—*e.g.*, *en raquette*, lateral skin flaps, or Spence's method—is far preferable, as (1) it allows of securing the artery before it is cut; (2) of exploring the condition of the head of the bone; (3) one flap can be cut longer, according to the state of the soft parts.

Means of arresting Hæmorrhage in Amputation at the Shoulder-joint.—These are mainly two:

1. **PRESSURE ON THE SUBCLAVIAN.**—I am of opinion that the more the surgeon trusts to this plan solely, the more often will he have cause to regret it. Pressure is always liable to be inefficient in short, fat necks: in thin patients, however well applied at first with the thumb aided by a padded key or weight, it is too often rendered uncertain by the necessary changes in position of the limb during the operation, or by the pressure of assistants, a violent gush of blood at the last showing to the surgeon that his confidence in the artery being secured is misplaced.† Furthermore, an assistant so used is necessarily much in the way of the others aiding the surgeon. For the above reasons I much prefer trusting to one or other of the two next given.

2. **COMPRESSION OF THE INFERIOR OR ANTERIOR FLAP, AND SO OF THE VESSELS BEFORE THEY ARE CUT** (pp. 128, 130. Figs. 60, 61).

* Finally the tendency of the skin to retract when this has been much stretched, as over a large tumour, should be remembered.

† In the case of a very stout patient, a small incision might be made over the third part of the subclavian, as at p. 113, to enable a finger to be placed upon the vessel.

3. LIGATURING OR TWISTING THE VESSELS ON THE INNER ASPECT OF THE LIMB BEFORE THEY ARE CUT (pp. 123, 125, Figs. 53, 56).

This method is an excellent one and suitable to all cases. The ligature should be placed as high as possible, so as to get above the circumflex arteries. The surgeon must be careful in the final use of the knife, high up in the axilla, not to prick the artery above his ligature.

4. LIGATURE OF THE SUBCLAVIAN ARTERY.—Mr. Howard Marsh successfully made use of this method in a case of amputation for an enormous "osteosarcoma" of the humerus.

After ligature of the third part of the subclavian, it was easy to empty back into the general circulation the blood out of the enormous vein, which ran over the surface of the growth. Eight ounces of blood was the amount estimated to have been lost.

5. LIGATURE OF THE FIRST PART OF THE AXILLARY ARTERY.—This step, originally recommended by Delpech, has been recently advocated by Prof. Keen (*Amer. Journ. Med. Sci.*, June 1894) in those cases where a growth has invaded the axilla high up. Thus, a free incision between the pectoralis major and deltoid will at once give us access to the apex of the axilla where the vessels lie, and enable us to determine how far the growth has extended.

6. WYETH'S METHOD BY PINS AND ELASTIC TUBING.—I mention this method here out of respect to the inventor, and the American surgeons who have used it. I do not recommend it for these reasons: It is clear from a paper by Prof. Keen, of Philadelphia (*Amer. Journ. Med. Sci.*, June 1894), that unless the pins are inserted very exactly—not an easy matter in operations of emergency—the tubing may slip, even when applied by this method. I consider the practice of finding the vessels and securing them before they are severed a great deal simpler and applicable to all cases. Finally, I cannot but think that, when a larger number of cases have been published in which the pins have been made use of, it will be found that the passage of long pins, even when sterilised, is not always "absolutely of no importance." Prof. Keen thus describes the method, which he used successfully in two cases, and which he thinks superior to every other:

Two sharp pointed pins, 11 inches long and of No. 20 French catheter size, are used. As much force is required to push the pins through the tissues, it is advised that the points should be made trocar-like. The anterior pin is introduced through the middle of the anterior axillary fold, at a point a little nearer to the body than what may be called the centre of the fold transversely. The point of emergence is of much greater importance, and should be an inch within the tip of the acromion. The second pin is inserted at a corresponding point through the posterior axillary fold, emerging again an inch within the tip of the acromion. Some care is needed to avoid striking the spine of the scapula. The pins being in position, a piece of black india-rubber tubing, half an inch in diameter, is bound tightly round the axilla and shoulder above the pins.

7. SECURING THE VESSELS LOWER DOWN, IN THE FURNEAUX-JORDAN METHOD (p. 131).

8. **USE OF AN INDIA-RUBBER BAND.**—This is applied after the same method as that fully given in amputation at the hip-joint. In my opinion it is unreliable, especially in those cases of accident in which, the limb being mutilated high up, this operation is chiefly required. For in these the band, being applied under the axilla and across the body, slips up as soon as the head is disarticulated, allowing of bleeding from the vessels, and coming, itself, most inconveniently into the way of the operator.

i. **Lateral Flaps—Oval—En Raquette** (Figs. 51 to 57).—The method of lateral flaps, or the above modifications of it, or

FIG. 51.



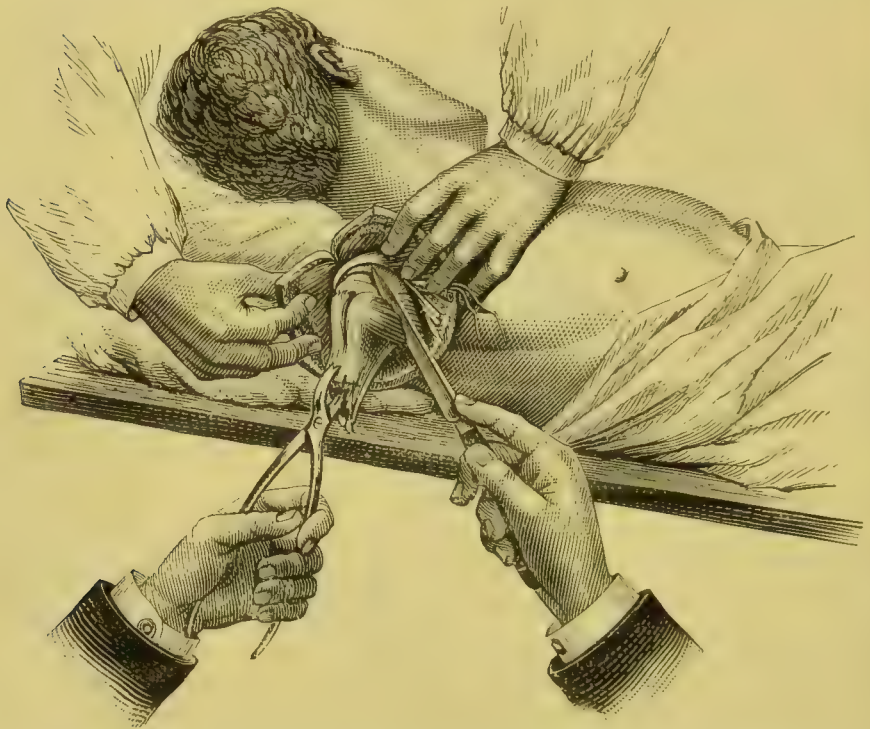
Spence's method, are those which the student is especially recommended to practise, on account of the advantages already given.

The methods of arresting the hæmorrhage are given above. The patient being propped up sufficiently, brought to the edge of the table, and rolled over to the opposite side, the surgeon,* standing outside the abducted limb on the right side, and inside it on the left, and having marked with his left forefinger and thumb a point just below and outside the coracoid process, and a corresponding point behind in the mid-axilla (Fig. 51), then reaches over, and, entering the knife in the axilla, close to the thumb, cuts an oval flap, about 4 inches long, consisting of skin and fasciæ, from the side farthest from him, and ending close to his finger. Without removing the knife, the surgeon next marks out a similar flap on the other side, cutting from above downwards, commencing just below the finger, and ending where the first flap began in the mid-axilla. The assistant in charge of the limb aids the above

* Three assistants are required here—(1) To manipulate the limb; (2) To grasp the artery in the inner or inferior flap, if desired; (3) To be ready with sponges or instruments. If the subclavian is to be controlled, this must be done by No. 3. If short-handed, the surgeon will manipulate the limb himself.

by rotating the limb into convenient position. The flaps are then dissected up and held out of the way. The vessels are next exposed (see p. 123), separated from the surrounding nerves, and secured, either by applying two pairs of torsion-forceps (Fig. 53), dividing the vessel between them and twisting both ends, or by passing an aneurism needle, loaded with carbolised silk or chromic gut, under the artery, and thus securing it with a ligature. The limb being then carried across the chest, the outer part of the capsule is freely opened by cutting on the head of the bone and the muscles

FIG. 52.



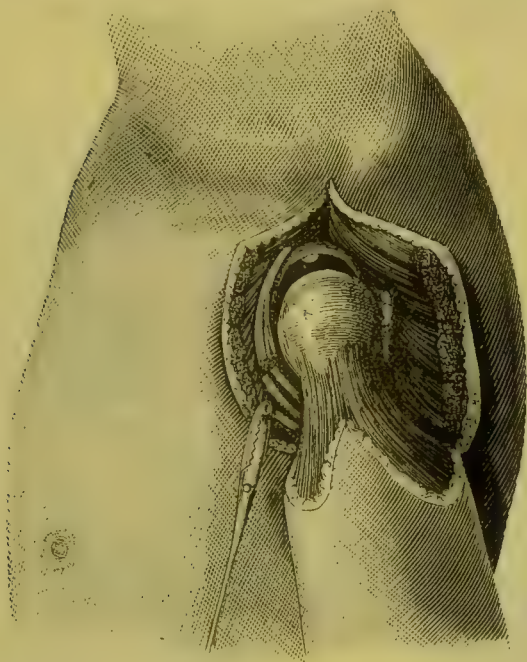
Disarticulation at the shoulder-joint. The operator with his left hand twists the humerus outwards, while, with his right, he divides the point of the capsule. (Farabeuf.)

attached to the great tuberosity thoroughly severed. The limb is next rotated outwards, and the sub-scapularis tendon severed; the biceps tendon being cut and the capsule freely opened, the joint is well opened on the inner side. The head being then dislocated,* by the assistant pressing the elbow forwards and against the side,

* This will only be feasible if the capsule has been deliberately and thoroughly opened. In any case where the leverage of the humerus is wanting, owing to this bone being broken higher up, the use of lion-forceps (Fig. 52) will facilitate disarticulation; or the surgeon will follow the expedient of Prof. Syme, quoted by Sir J. Lister (*Syst. of Surg.*, vol. iii. p. 712), and introduce his finger into a wound in the capsule, for the purpose of drawing down the head of the bone, so as to gain access to its attachments.

the knife is passed from the outer side behind the dislocated head, and, being kept close to the inner side of the bone, is brought out through the structures on the inner aspect of the arm, care being taken, as the knife cuts its way out, that it does so below the point where the large vessels have been secured.

FIG. 53.



Amputation at the shoulder-joint by lateral flaps. These are turned aside, while the axillary artery is secured by torsion before disarticulation is completed.

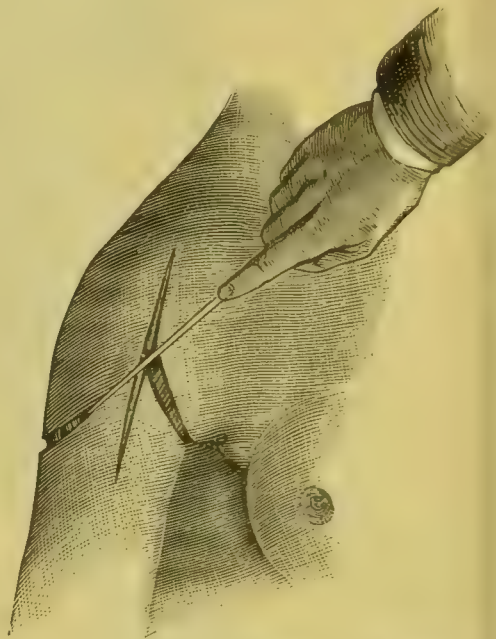
Method en Raquette with Preliminary Exploration (Fara-beuf) (Figs. 54 to 57).—The point of the knife being sunk just below and in front of the tip of the acromion, an incision is made downwards, sufficiently long and deep to admit of exposing the head of the humerus. If amputation is decided on, the above is converted into one *en raquette* by making an oblique incision which passes from about the centre of the longitudinal one (Figs. 54 and 55) across the inner or the outer aspect of the limb (according as it is right or left) and ends behind on a level with the lower extremity of the longitudinal one. A second exactly symmetrical to the first is next made over the opposite aspect of the limb, beginning where the first ended and terminating in the longitudinal incision opposite to the first (Fig. 55). The next step is the exposure of the artery by division of the muscles. In the curved inner incision (Fig. 56) are seen the anterior fibres of the deltoid almost blended with the insertion of the great pectoral. This is raised with the finger, and the insertion of the great pectoral detached from the bone. If now the inner flap is folded

inwards, the coraco-bicipital fasciculus comes into view. The aponeurosis over it being opened by a free longitudinal incision, the muscular fasciculus is drawn over the front of the humerus and cut across. If an assistant now thoroughly retracts the inner flap, the axillary vessels and nerves are exposed. The artery should be isolated and tied as high up as possible, so as to get above the posterior circumflex. The knife being again inserted into the outer oblique incision, the deltoid is boldly cut through as far as the back of the axilla. An assistant next retracts the outer and

FIG. 54.



FIG. 55.



Amputation at the right shoulder-joint by the method *en raquette*. The knife is tracing the flaps, after a free exploratory incision has been made. (Farabeuf.)

inner flaps, while the surgeon opens the capsule freely, rotating it as directed (p. 122). The head is next thrown out of the socket, and the knife is carried behind the head, skirting the postero-internal aspect of the humerus very closely, so as not to cut the secured artery, and finally brought out through the incision on the inner side, severing the latissimus dorsi and teres major. If the artery has not been tied, an assistant secures it between his thumb, sunk deeply into the wound, and his fingers, which are in the axilla, or by using both hands.

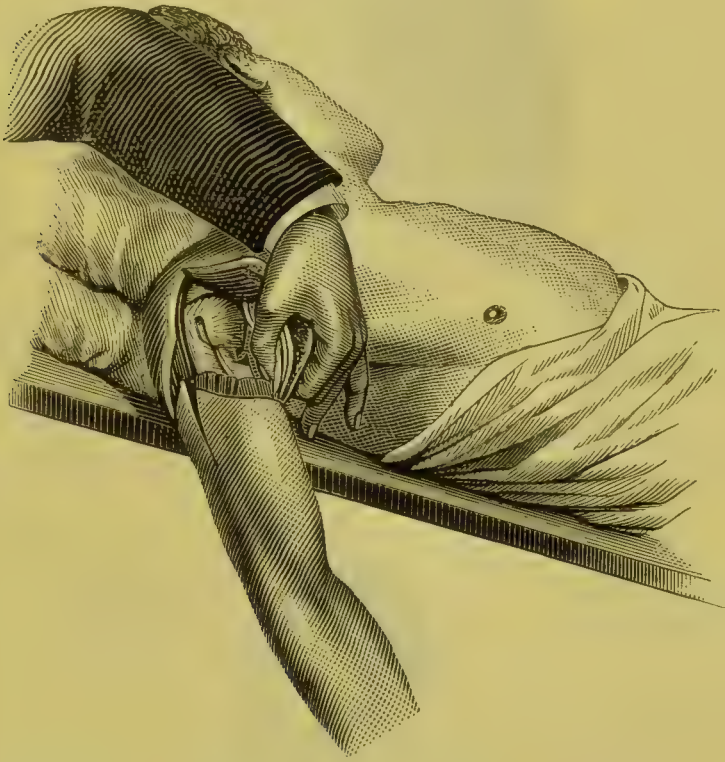
ii. **Spence's Method** (Fig. 59).—This excellent modification of the oval method is especially suited to cases of failed excision,* or to cases of injury—*e.g.*, gunshot—where the surgeon has to cut into and explore the condition of the joint before deciding on excision

* At the present day, in cases of failed excision, the surgeon will often prefer to make use of the modification of the Furneaux-Jordan method, p. 131.

or amputation. By its means an excision can readily be converted into a disarticulation, if this step is found needful.

Other advantages, but less important ones, are—1. The posterior circumflex artery is not divided, except in its small terminal branches in front, whereas, both in the large deltoid flap and the double flap methods, the trunk of the vessel is divided in the early steps of the operation, and, retracting, often gives rise to embarrassing hæmorrhage. 2. The great ease with which disarticulation can be accomplished. 3. The better shape of the stump. Prof.

FIG. 56.



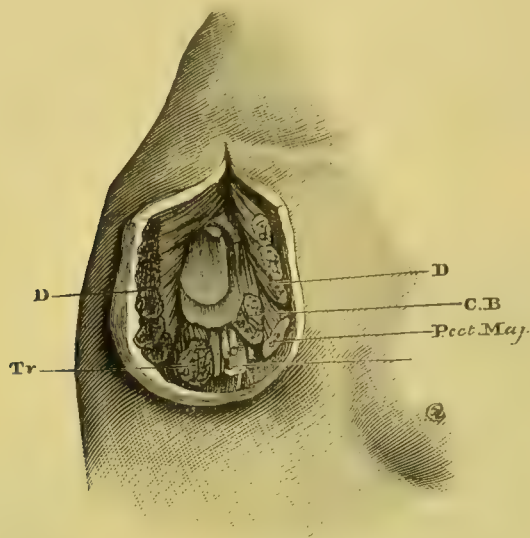
The anterior fibres of the deltoid, the insertion of the pectoralis major, and the coraco-brachialis and biceps have been cut. The left hand of the operator draws the large nerves downwards, and thus exposes the axillary artery for ligature. (Farabeuf.)

Spence pointed out that, however excellent are the results soon after other methods, later on the shape of the stump is much altered, not merely from the atrophy common to all stumps, but from retraction of the muscular elements of the flaps, the pectoralis major retracting towards the sternum and the latissimus dorsi and teres major towards the spine and scapula. Thus a deep, ugly hollow results under the acromion.

Fig. 58 shows an instance of this, as the result of amputation high up in the humerus, in a young subject. E. D., aged ten, was admitted under my care in Guy's Hospital for a terrible crush of both upper extremities, from his having been run over by a timber-

waggon. I amputated at once through the left shoulder-joint by superior and inferior flaps. An attempt was made to save the

FIG. 57.



Parts composing the flaps made by the *en raquette* method. (Farabeuf.

right limb, but owing to gangrene setting in amputation became necessary, and was performed high up through the humerus by

FIG. 58.



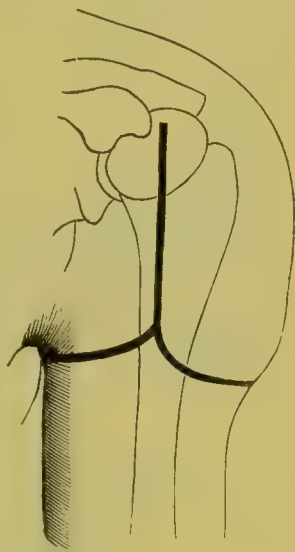
Edward
Davies.

Mr. G. A. Wright, of Manchester, then house surgeon. The resulting projection of the acromion from wasting of the muscles was well shown when, nine years later, he again came under my care

for a conical and tender stump on the right side, due here to the unbalanced growth of the upper epiphysis. The writing below was done by the lad with his teeth.

The operation is thus described in Prof. Spence's words : *
 "Supposing the right arm to be the subject of amputation. The arm being slightly abducted, and the head of the humerus rotated outwards if possible, with a broad strong bistoury I begin by cutting down upon the head of the humerus, immediately external to the coracoid process, and carry the incision down, through the clavicular fibres of the deltoid and pectoralis major, till I reach the humeral attachment of the latter muscle, which I divide. I then, with a gentle curve, carry the incision across and fairly through the lower fibres of the deltoid towards the posterior border of the axilla, unless the textures be much torn. I next mark out the line of the lower part of the inner section by carrying an incision through the skin and fat only, from the point where my straight incision terminated, across the inside of the arm, to meet the incision at the outer part. This insures accuracy in the line of union, but is not essential. If the fibres of the deltoid have been thoroughly divided in the line of incision, the flap so marked out can be easily separated (by the point of the finger, without further use of the knife) from the bone and joint, together with the trunk of the posterior circumflex, which enters its deep surface, and drawn upwards and backwards, so as to expose the head and tuberosities. The tendinous insertions of the capsular muscles, the long head of the biceps, and the capsule are next divided by cutting directly on the tuberosities and head of the bone, and the broad sub-scapular tendon especially, being very fully exposed by the incision, can be much more easily and completely divided than in the double flap method. By keeping the large outer flap out of the way by a broad copper spatula or the finger of an assistant, and taking care to keep the edge of the knife close to the bone, as in excision, the trunk of the posterior circumflex is protected. Disarticulation is then accomplished, and the limb removed by dividing the remaining soft parts on the axillary aspect. The only vessel which bleeds is the anterior circumflex, divided in the first incision, and here, if necessary, a pair of catch-forceps can be placed on it at once. In regard to the axillary vessels, they can either be compressed by an assistant before completing the division of the soft parts on the axillary aspect, or, as I often do in

FIG. 59.



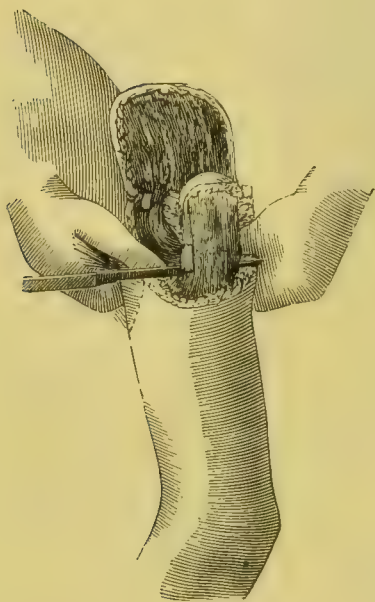
Amputation at the shoulder-joint by Spence's method. (Stimson.)

* *Lancet*, 1867, vol. i. p. 143; and *Lect. on Surg.*, vol. ii. p. 662.

cases where it is wished to avoid all risk, by a few touches of the bistoury the vessel can be exposed, and can then be tied and divided between two ligatures, so as to allow it to retract before dividing the other textures." *

iii. **Amputation by Superior and Inferior Flaps** (Figs. 60 and 61).—The patient being brought to the edge of the table turned sufficiently over, and his shoulders supported by pillows, the assistants are arranged as before. The arm being a little raised so as to relax the deltoid, the surgeon, standing inside the limb on the right side and outside it on the left, lifts the deltoid muscle with his left hand and sends the knife (narrow, strong,

FIG. 60.



and no longer than needful) across beneath the muscle, entering it on the right side, just below the coracoid process, and bringing it out a little below the most prominent part of the acromion,† or *vice versa*, according to the side operated upon. The knife should pass close to the anatomical neck of the humerus, without hitching upon it, and the flap should be cut broadly rounded, and well down to the insertion of the deltoid. It is then raised and retracted, and, the capsule being now exposed, the joint is opened by cutting strongly upon the head of the bone. The arm being now rotated outwards vigorously by an assistant or by the surgeon, the sub-scapularis, thus made tense, and the biceps are brought into view and severed; the limb is next rotated inwards, being carried across the chest, and the muscles attached to the great tuberosity are divided. The capsule is next still more freely opened, and the head of the bone, now freed, is pushed up by the assistant and pulled outwards from the glenoid cavity. The knife is next slipped behind the head (Fig. 60), and cuts its way along the under aspect of the neck and shaft of the humerus, so as to shape an inferior flap half the length of the upper one.‡ As soon as the knife is passed behind the bone, an assistant slips his hands in behind the back of the knife (Fig. 60), following it so as to grasp firmly the soft part in the inferior flap, and thus control the axillary vessels (Fig. 61).

* Where the limb is very muscular, Prof. Spence recommended to raise the skin and fat from the deltoid at the lower part, and then to divide the muscular fibres higher up by a second incision, so as to avoid excess of muscular tissue.

† Unless care is taken to keep thus below the acromion process, there will be some tendency for this bone to protrude in the wound.

‡ The surgeon should not cut this till he is told that the flap is held firmly and, in cutting it, he must be careful of his assistant's fingers.

The large vessels are next secured, then the circumflex, and any muscular branches that require it; any large nerves that need trimming are then cut short, drainage provided, and the flaps brought into position.

This amputation has the advantage of being very quickly done, and of giving a flap which keeps in position by its own weight, and thus gives good drainage. If the soft parts below the humerus are much damaged, the upper flap must be cut proportionately long.

iv. **Amputation by Deltoid or Upper Flap.**—This is merely a modification of the last. The deltoid or upper flap may be cut by transfixion, or made by cutting from without inwards.

FIG. 61.



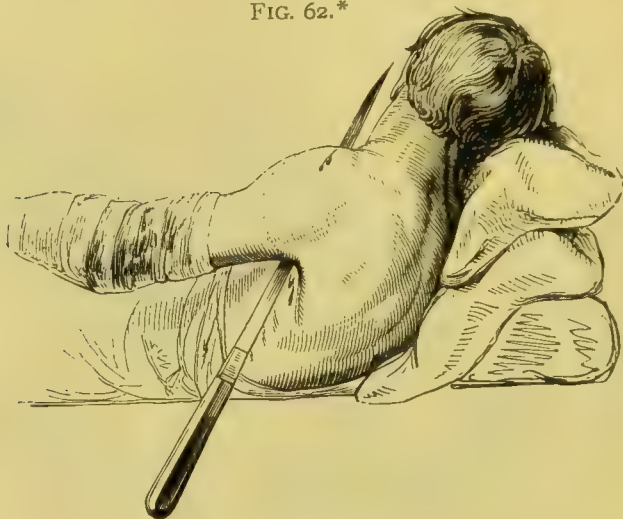
To show the manner in which bleeding is controlled in the inferior flap: the axillary vessels are compressed by one thumb, the posterior circumflex by the other.

In either case it must be of very full size, and thus is useful when the axilla is damaged, but it has the disadvantage of leaving next to no flap in which an assistant can seize the axillary vessels; and, owing to the powerful retraction of the muscles in the axillary folds, unless the upper flap is cut full in length and size it will not cover the resulting wound. Finally, as the trunk of the posterior circumflex is cut, sloughing of the large deltoid flap may take place, especially if the tissues composing it are at all damaged previous to the amputation. Owing to these disadvantages, which outweigh its rapidity, this method is not to be recommended, a short under-flap being always cut if possible. When the surgeon, having disarticulated, is cutting straight down, unable to make any flap below, assistant (2)—(footnote, p. 118)—should try to draw up the skin of the axilla, while assistant (1),

in charge of the limb, should be careful not to draw down the skin, otherwise, owing to the laxity of the skin in the axilla, any downward traction will bring the skin of the thoracic wall under the knife.

v. **Amputation by Anterior and Posterior Flaps** (Fig. 62).—This is indicated when the soft parts on the front and inner aspects are damaged. The position of the patient being as before, and the limb being carried somewhat upwards, backwards, and outwards, the surgeon, standing, if on the left side, behind and outside the shoulder, enters his knife just in front of the posterior fold of the axilla, thrusts it across the back of the humerus as near the head as possible, so as to get in front

FIG. 62.*



(Fergusson.)

of the tendons of the *teres major* and *latissimus dorsi*, and bringing it out close to the acromion, cuts, with a sawing movement, a flap, 4 to 5 inches long,† which is next well retracted by an assistant. The arm being then carried across the chest, the joint is freely opened behind, the muscles attached to the tuberosities severed, the knife passed between the head and the glenoid cavity (to facilitate this, the limb should now be carried over the chest, and the head of the bone pushed backwards), then between the bone and the *pectoralis major*, and an anterior flap,‡ 4 inches long, cut from within outwards. Hæmorrhage from the large vessels is arrested either by an assistant grasping this flap as it is cut, much as at p. 128, or by the surgeon isolating the axillary vessels (the *biceps* and *coraco-brachialis* will guide him) and

* The knife in this drawing is represented as far too large.

† In the posterior flap will be the posterior part of the *deltoid*, the *latissimus dorsi*, and *teres major*.

‡ In this anterior flap will be the remaining fibres of the *deltoid*, the *pectoralis major*, and the large vessels and nerves.

securing them by torsion or ligature (p. 123) before he completes the operation by cutting the anterior flap. When operating on the right limb, the patient being turned well over on to his left side, the surgeon, standing here inside the arm, which is held upwards and backwards so as to relax the deltoid, lifts this muscle up with his left hand, and then passes his knife from just below the acromion, transfixing the base of the deltoid, grazing the back of the humerus, and finally thrusts the point downwards and backwards through the skin till it comes out at the posterior margin of the axilla. This flap, 4 or 5 inches long, should be dissected up, the joint opened behind, and the operation completed as before.

vi. **Furneaux-Jordan Method.***—This may be made use of both as a primary and a secondary amputation. The following are suitable cases :

a. Certain cases of injury. Where, though the parts about the shoulder-joint are intact, the humerus is badly split up into the joint. The soft parts are divided down to the bone by the circular method, 3 to 4 inches below the axilla, the main vessels secured, and the humerus then shelled out by a longitudinal incision along the outer and posterior aspect of the limb, meeting the circular one at a right angle.

b. In cases of failed excision. Here, after amputation of the limb by the circular method, the rest of the bone is turned out through the excision wound prolonged into the circular one.

c. After amputation in the middle of the arm in some cases. *E.g.*, when the stump is the seat of osteo-myelitis, necrosis, or otherwise does not do well.

EXCISION OF SHOULDER-JOINT (Figs. 63 to 67).

This operation is but rarely performed—(1) owing to the comparative infrequency of diseases of the above joint, especially of pulpy disease, which require operative measures; (2) from the fact that epiphysitis and septic synovitis usually give (after free incision and drainage) as good a result as can be obtained after excision. This is mainly owing to the fact that much of the stiffness that otherwise would be present is made up for by the supplementary mobility of the scapula, especially in young subjects.†

The above remarks naturally lead up to the consideration of *the amount of movement which is gained after the operation of excision*. The arm cannot usually be abducted and elevated beyond

* For the details of this method, see "Amputation at the Hip-joint."

† In future, by the use of a simple longitudinal incision with a minimum of interference with the deltoid, aided by antiseptic precautions from the first, and with earlier and persevering adoption of passive movements, the above statement may have to be modified.

the horizontal line; too often it lies close to the chest. Even if the deltoid retained its power of elevation, it could not often exert it, as in most operations, owing to the amount of bone removed, the fulcrum of the head of the humerus against the glenoid cavity has gone. Prof. Longmore (*Resection of the Shoulder-joint in Military Surgery*, p. 12) writes:—"The loss of the elevating action of the deltoid must be accepted, like the loss of the rotating power from the division of the muscular insertions into the two tubercles, as a necessary consequence of resection of the head of the humerus. But the holding or supporting power of this muscle exerted upon the whole upper extremity owing to its position, its extensive origin, and the manner in which it embraces and protects the mutilated parts, as well as its faculty of assisting in carrying the arm backwards and forwards, are all functions which may still remain, and serve to point to the great importance of preserving its integrity as fully as possible. The wasting of the internal fibres (Fig. 63), however, seems a necessary result of resection by the single incision, but it has this compensating feature, that it is a less serious loss to the patient than an atrophied condition of the outer and posterior fibres would be, because the upper clavicular fibres of the great pectoral can take the place of the inner deltoid fibres to a considerable extent in supporting the shoulder and drawing it forwards to the chest."

Sir J. E. Erichsen (*Surgery*, vol. ii. p. 251) says of the four chief movements of the shoulder-joint—viz., "(1) abduction and elevation, (2) adduction, (3) and (4) movements in the antero-posterior direction—these are requisite in all ordinary trades for the guidance of the hand in most of the common occupations of life. The movements of elevation are seldom required save by those who follow climbing occupations, as sailors, masons, &c. Now, the mode of performing the operation, as well as the operation itself will materially influence these different movements. Thus, if the deltoid be cut completely across, the power of abduction of the arm and of its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision, they may be regained in great part. All those movements of rotation, &c., which are dependent on the action of the muscles that are inserted into the tubercles of the humerus will be permanently lost; for, in all cases of caries of the head of the humerus requiring excision, the surgeon will find it necessary to saw through the bone below the tuberosities—in its surgical, and not its anatomical, neck.* Hence the connections of the supra-spinatus and infra-spinatus, the teres minor, and sub-scapularis will all be separated, and their action o

* With all proper deference to the opinion of Sir J. E. Erichsen, this opinion appears to be too definite and inelastic. I would refer the reader to the remarks below on the site of section of the bone, and on sub-periosteal resection (pp. 143).

the bone afterwards lost. But those muscles which adduct, and which give the antero-posterior movements—viz., the coracobrachialis, the biceps, the pectoralis major, latissimus dorsi, and teres major—will all be preserved in their integrity; and hence it is that the arm, after this excision, is capable of guiding the hand in so great a variety of useful under-handed movements.”

Indications.

i. Different forms of arthritis disorganising the joint, resisting careful treatment, in subjects whose age, general condition, &c., are satisfactory—viz.:

(a) Pulpy synovitis, resisting other treatment and going on to caries. (β) Disorganisation of the joint after rheumatic fever, gonorrhœal rheumatism, wrenches, &c., resulting in crippling ankylosis, in a young subject. (γ) Ostitis going on to suppuration, caries, &c. (δ) Epiphysitis, suppurating or acute necrosis, where discharge, sinuses, &c., are exhausting the patient, and the outlook as to natural cure is not good. (ε) Disease of the deltoid bursa ulcerating into the joint and setting up destructive arthritis.

ii. Gunshot injuries, where the large vessels and nerves have escaped, where fragments of shell, bullets, &c., are lodged in the head of the bone, especially if the shaft of the bone is not much damaged (p. 115).

iii. Compound dislocation and compound fracture with much damage to the capsule and cartilage of the head of the bone, the large vessels and nerves being intact.

iv. Some cases of unreduced dislocation of the head of the humerus. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 738) wrote long ago: “I have often thought that, in cases of irreducible dislocation attended with much pain, the removal of the head of the bone might be justifiable, but have not met with any case in which the operation has been performed.” Sir J. Lister (*Ed. Med. Journ.*, March 1873) excised the head of the humerus after securing a rupture of the axillary artery,* this vessel having given way in an attempt to reduce a dislocation of eight weeks’ standing. The patient, aged fifty-eight, sank three hours later. Considering the frequency with which this accident has taken place in attempting to reduce old dislocations of the shoulder, it would be wiser, in

* The condition of the parts found here is most noteworthy. A broad and strong fibro-osseous band, connecting the humerus with the coracoid process, lay over the head of the bone, and at the same time was intimately connected throughout by condensed tissue with the sheath of the axillary artery, which lay over it. Thus, the vessel, instead of being surrounded by loose and yielding structures, was attached by an osteo-fibrous band to the coracoid process on the one hand, and the neck of the humerus on the other; and when these were separated from one another by the attempts at reduction, the artery as well as the band was subjected to violent traction. Accordingly, the band, strong as it was, was found to have been torn right across, and the rent in it was exactly opposite to the rupture in the artery. Atheroma in the vessel served to explain still further the disaster.

these days of antiseptic surgery, to attempt to improve the condition of things by excising the displaced head. Mr. Sheild brought before the Medico-Chirurgical Society (March 13, 1888) a man, aged forty-five, on whom he had performed excision for a neglected sub-coracoid dislocation of twelve weeks' standing.

Owing to implication of the median and ulnar nerves, the hand was almost useless. Moderate attempts at reduction having failed, the head was removed through the anatomical neck, this site being chosen in order to disturb the parts as little as possible. The end of the bone was made as like the real head as possible by careful rounding. Twelve weeks afterwards the patient was able to resume work as a waiter. The movements of the shoulder were satisfactory, and the hand gradually regained strength.

Sir Joseph Lister has published (*Brit. Med. Journal*, 1890, vol. i. p. 1) two similar cases treated by operation, but somewhat differently.

They were both instances of bilateral sub-coracoid dislocation, due in the one case to a fall from a tree, in the other to epilepsy. The patients, aged forty-seven and twenty-three, were each pitifully helpless. In three of the joints, the usual incision having been made between the deltoid and pectoralis, the sub-scapularis tendon was divided, and the soft parts detached from the head of the bone and the inner side of its neck. This was done to insure the vessels being entirely set free from the head of the bone. The pulleys were next used, and the head not returning, it was protruded out of the wound, and the insertions of the external rotators cut through, after which the pulleys were used successfully. In the case of the fourth joint the articular portion of the head was removed piecemeal with a chisel, without interfering with the tuberosities or the external rotators. This allowed the head to drop readily into the glenoid cavity. The result of these operations was "a grand success," but Sir Joseph thought that excision gave a result inferior to the other.

In Sir J. Lister's words (*loc. supra cit.*, p. 3):

"The attachments of all the rotators to the tuberosities were divided, and yet you saw that they have completely re-formed; rotation is perfect, both external and internal. And in the other patient, though the dislocation had been of so much longer standing (seven months), the use of the previously wasted rotators had been completely restored. I would advise that when the surgeon feels in doubt as to whether it is prudent to make attempts at reduction, or when such attempts do not succeed, he should, in the first place, cut down upon the bone by the usual incision from the coracoid process downwards and a little outwards, and then, with a curved periosteum-detacher, freely separate the soft parts from the inner side of the upper end of the humerus. You will then be sure that no damage will be done to the axillary vessels in any manipulations which you may make. In many cases you will doubtless succeed by these means: but if this fails, then these instances show that you may proceed to turn out the head of the bone, detaching the insertion of the rotator muscles, and after reduction you will have a thoroughly useful limb. Should even this procedure fail, removal of the head of the bone is easily open to us, with the promise of a good though inferior result."

It is noteworthy that in the case of reduction without excision there was a remarkable tendency to the formation of adhesions, and the recovery of movement was extremely slow. In another, the maintenance of passive movement kept up a serous oozing and delayed the healing of the wound. Strict antiseptic precautions are needful throughout, as, if inflammation sets in, ankylosis is almost certain.

Mr. Pearce Gould and Mr. Watson Cheyne showed similar cases at the Medical Society (*Lancet*, 1892, p. 474).

Reduction was in each case effected after division of the muscles. In one case the range of movement was somewhat defective, and there was a tendency for the head of the humerus to slip forward. But here four months had elapsed between the dislocation and the reduction; it was needful in this case to clear out the glenoid cavity, and the patient failed to attend subsequently.

Mr. Southam (*Brit. Med. Journ.*, vol. ii. 1892, p. 1193) published a case in which he had excised the shoulder-joint for a frequently recurring dislocation in a woman aged forty-five.

Nothing abnormal, beyond slight grating, could be detected on examination, but, under anæsthesia, a sub-coracoid dislocation could be readily produced, and as readily reduced. At the operation a small part of the anterior rim of the glenoid cavity was absent. The head of the humerus was sawn through the anatomical neck; gentle passive movements were begun three weeks after the operation, and twelve months later there had been no recurrence of the dislocation. The arm was then very useful, with good movements, the patient being able to perform her ordinary household duties.

Mr. Thorburn (*Med. Chron.*, vol. xiv. p. 8) excised the head of the humerus through the surgical neck, in a case diagnosed as sub-clavicular dislocation and fracture, with irregular formation of callus. He points out that division of tendons would here have been insufficient, as such a deformed head, if even thus reduced, would not have fitted into the glenoid cavity.

v. A few cases of growth connected with the upper extremity of the humerus. Whilst the priceless value of the hand fully justifies the attempt in some instances, such cases must be extremely rare.

Perhaps it is owing to this rarity that this matter has received so little attention.

The best reported English case with which I am acquainted is one in which Mr. Mitchell Banks* endeavoured to save the upper extremity of a patient by excising the upper end of the humerus, the site of a sarcomatous growth originally enchondromatous.

S. D. was a spare, placid man of fifty-six, a chapel-keeper. So far back as the summer of 1865 he was seized with violent pain near the right shoulder, and after that came a hardness and swelling at the top of the humerus, which very slowly increased. As it gave him no great inconvenience, he did not heed it much for many years, but by 1878 it had grown to be as big as a cocoanut, so that, on attempting to raise the arm, it became locked against the acromion, limiting movement, while pain of a severe character set in. In June 1878 the tumour was removed by cutting down upon it, and dissecting off the tissues from over it. As it grew from the outer surface of the upper third of the humerus, this was effected without difficulty. Then with a mallet and chisel it was cut cleanly away from the bone, and the surface from which it sprang was thoroughly scraped—a pretty broad surface, by-the-way. I left no cartilaginous remains that could be seen. The patient rapidly recovered, but in the tract of the wound

* *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 6. It is much to be desired that this original and most instructive writer would give to the profession, with equal vigour and terseness, some more of his experience.

a sinus or two persistently remained, leading down to the bone. After the lapse of about two years it became clear that the tumour was returning, and by the summer of 1881—three years after the first operation—it had attained an immense size, having taken a fit of growing during the last few months. It clearly arose from the same site as before, but now it filled up the axilla, and had even got beneath the great pectoral. Pain and rapidity of growth demanded its speedy removal. But removal of a whole right arm at the shoulder-joint seemed such a dreadful thing, that one was anxious to save a hand and forearm by carrying away, if possible, the tumour and upper part of the humerus, even although the upper arm might remain useless. The patient being made well aware that, in case of the failure of this project, there was nothing left but amputation, I attempted it. The incisions necessary to lay bare the tumour were very extensive, the chief one reaching from above the acromion, half-way down the outer side of the upper arm. With much trouble, and after the loss of a great deal of blood, the outer and upper surfaces of the growth were exposed, and the humerus was disarticulated from the scapula. Then, sawing through the humerus, about an inch below the deltoid insertion, I attempted to dissect away the tumour from the brachial vessels and nerves. Here, however, most serious difficulty was encountered, from their intimate incorporation with the growth, and at last, after a prolonged attempt, I was reminded by my colleague, Mr. Harrison, that the patient had plainly endured as much as he could, and that to make further effort might only lead to collapse on the table. I was reluctantly compelled to admit this, and so rapidly swept the limb away at the shoulder. So profound was the shock, that a short time after the operation the temperature fell to 95° , and remained so for many hours. The operation was conducted antiseptically, and the patient, in spite of the loss of blood, made such a rapid recovery that on the twenty-third day he left the infirmary quite well, and remains so now, two years after the amputation. If the great vessels and nerves had not been so seriously enveloped by the growth, the limb would have been saved, although with the loss of the upper half of the humerus. But even a forearm is better than no arm at all. The case also shows that chiselling off cartilaginous tumours is not by any means a certain removal. The surface that was left upon the humerus, after the first removal of the tumour, looked perfectly healthy to the naked eye, but there must have been cartilage cells deep down in the tissue of the bone.

Mr. Southam (*Med. Chron.*, January, 1887, p. 291), has recorded a successful case of resection of the upper end of the right humerus for an endosteal (mixed-cell) sarcoma:

A large deltoid flap was made, and the head and 4 inches of the shaft of the humerus removed. Six months later the patient, aged thirty, could raise her hand to the mouth, use her arm for household work and in using a small sewing machine. Though, with the arm hanging by the side, there was an interval of about 4 inches between the acromion and upper end of the humerus, the distance could be considerably diminished by the action of the biceps and triceps, and coraco-brachialis. A good illustration accompanies this instructive case.

Mr. J. Hutchinson has recorded (*Path. Soc. Trans.*, vol. viii. p. 346) a case of resection of the upper part of the humerus for a large myeloid growth. The following is a summary of the case:

Supposed fracture of the neck of the humerus in a woman, aged twenty-seven. Permanent loss of movement and gradual enlargement above the spot. Amputation at the shoulder-joint advised fourteen months after the accident, on account of a large tumour which had formed—refused by the patient. Arrest of the growth for four years. Subsequent rapid growth and enlargement of glands.

Resection of the upper third of the humerus, and removal of the diseased glands. Recovery, with a useful arm, but rapid reproduction of the disease in four different parts. Death, five months after the resection, from an enormous mass, with sloughing and bleeding. Secondary growths connected with the bone, axilla, cervical glands, and lung.

Methods.

- i. By an anterior straight incision (Figs. 63 to 67); usually anterior.
- ii. By a posterior incision, straight or curved.
- iii. By a deltoid flap.

The first only need be referred to at any length here.

FIG. 63.



Excision of shoulder-joint by a straight incision placed just outside the coracoid process. As only the anterior part of the deltoid is cut, the posterior circumflex artery and the circumflex nerve are less damaged. (Péan.*) The above important structures cross the humerus at the surgical neck, on a level that corresponds to a horizontal line drawn about a finger's breadth above the centre of the deltoid.

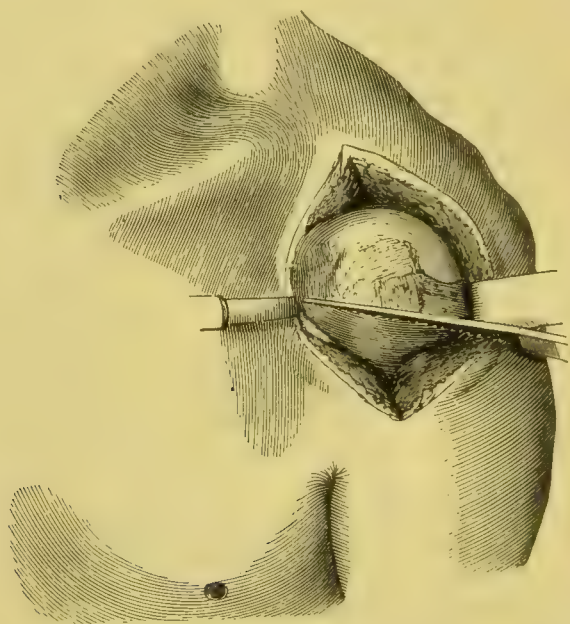
- i. **By anterior incision.**—The patient being rolled a little over, and the shoulder supported by a pillow, the surgeon, standing at the shoulder facing the body, with an assistant opposite to him, and another seated to manipulate the limb, makes an incision, $3\frac{1}{2}$ inches long, commencing just outside the coracoid process, and on a level with it, through skin and fasciæ; the deltoid† is then

* J. Péan, *De la Scapulalgie, et de la Résection scapulo-humérale* (Paris, 1860).

† The advantage of an anterior incision starting from just outside the coracoid instead of from the acromion is that all the posterior and outer part of the deltoid (so powerful in abduction) is left intact, together with the circumflex vessels and nerve, with the exception of the terminal filaments going to the anterior part of the muscle, which alone is interfered with.

divided for the same length, retractors inserted, and, if the arm has been rotated outwards, the bicipital groove will be seen lying at the bottom of the wound.* The condition of this important tendon will vary much: (1) it may be normal; (2) it may be surrounded with pulpy material; (3) it may be frayed and adherent to the bone; (4) it may be ulcerated or absent. Whenever it is possible to preserve it, it should be carefully separated from its groove and drawn aside with a blunt hook. The capsule is next to be opened freely, care being taken to do this high up, over the head of the bone, and the arm being strongly rotated outwards, the subscapularis is divided; then, after rotation inwards, the three muscles attached to the great tuberosity are cut through, and the

FIG. 64.



capsule still more freely opened. In detaching the tendons,† an in sawing the bone, if this is done *in situ*, care must be taken, b keeping the arm somewhat separated from the body, and th elbow a little raised, to relax all the parts of the capsule. Unless this is done, the edges of the wound in the capsule are stretche tight, the finger is nipped, and there is no room for working wit a saw, knife, or elevator.

The bone may be divided in two ways:—(1) *In situ* (Fig. 64) A blunt director is passed under the bone from within outward so as to protect the soft parts; the bone is sawn through with

* Farabeuf advises, to insure the bicipital groove being found easily, that t arm be kept midway between abduction and adduction, a position secured placing the hand (the body being horizontal) on the anterior superior spine.

† In the detachment of the tendons a blunt-pointed knife should be use and kept very close to the bone. The biceps must be carefully protected throug out.

narrow-bladed or a chain saw, seized with lion-forceps, and twisted out, the levering movements of an elevator, or a few touches of the knife, aiding this. (2) The head is first thrust out of the wound by pushing up the elbow, and then sawn off. This method is certainly the easier, but disturbs the soft parts more.* The former is perfectly safe, and inflicts less damage on the surrounding tissues; finally, where ankylosis is present, it may be most difficult to thrust the head out.† Mr. Treves, on the other hand, considers that this method is less precise, little opportunity is given of fully examining the part, and the tissues around may be damaged by the saw. Whichever plan is adopted, the soft parts should be scrupulously protected. The truncated end of the shaft should be carefully rounded off with cutting-forceps, especially in the neighbourhood of the nerves, and Mr. Sheild's plan of trying to reproduce the shape of the old head may be tried.

ii. By a posterior incision.

Sir W. Mac Cormac describes a method by a straight incision made vertically downwards for about 4 inches from the prominent angular projection so plainly felt on the inferior margin of the acromion. This method is not to be recommended, as by it the trunk of the circumflex nerve is cut through. As by approaching the joint from behind better access is got to the glenoid fossa, Kocher has recommended a posterior curved incision. This, though it has the advantage of interfering but little with the deltoid, is a complicated method, involving division and possibly subsequent caries of the spine of the scapula. The chief steps are: a curved incision is made from the acromio-clavicular joint over the highest part of the shoulder, along the spine of the scapula to near its middle, thence curving downwards to a point two fingers' breadth above the posterior axillary fold. The upper part opens the acromio-clavicular joint, the lower opens the fascia along the posterior margin of the deltoid.

The bulk of this muscle is then pulled vigorously forward, those fibres alone which are attached further back along the spine being cut. The attachment of the trapezius being separated above at the spine, the supra- and infra-spinatus are detached so that the fingers can seize the spine where it rises from the scapula. At this point the spine is cut through with a chisel, care being taken not to injure the supra-scapular nerve. The acromial portion is then turned forwards, and with it the great bulk of the deltoid, which is now detached from the dorsal muscles of the scapula, to which it is only connected by loose connective tissue. The outer and posterior aspects of the joint, covered by the tendons of the external rotators, are now freely accessible, and the operation is completed by the steps already given. The divided ends of the spine are subsequently wired.

This method certainly allows of a freer inspection of the glenoid fossa, and if tubercular disease were a common affection of this joint in this country and we thus needed to remove affected tissues from every part of the joint, a posterior free incision would be indicated. But as this is not the case, as such posterior incision is more complicated than the anterior straight one already

* It must not be forgotten that these soft parts are largely made up of important nerve cords. I have seen this operation followed by tetanus in a case in which the surgeon was obliged to rely on most inadequate instruments.

† In one of M. Ollier's cases, as the head of the humerus was being thrust out through the wound, the bone, which was very fragile, was broken across just above the condyles. This accident ultimately exercised no untoward influence on the result.

described, and as the latter, by the careful use of retractors, allows us sufficient access to the glenoid fossa, I give a decided preference to it.

iii. **The deltoid flap** gives more room, and thus facilitates the operation considerably, but the larger scar, and far greater, in fact almost total, impairment of deltoid power are such serious drawbacks* that it is, nowadays, hardly ever used. If the head of the humerus is very much shattered, if the soft parts are much matted and thickened, if there is any special reason for completing the operation rapidly, in the rare cases of excision attempted for large growths, for the sake of more complete exposure (p. 135), this method may, though very seldom, be made use of.

SITE OF SECTION OF THE BONE (Fig. 64).—It being most important to leave the humerus as long as possible, not an atom more than is needful should be removed. The section should be made just below the articular surface in every case where this will remove the whole of the disease, and where all the head must go. The advantages of sawing here over division through the surgical neck are—(1) A longer humerus is left to be brought against the glenoid cavity, and aid, as a fulcrum, the action of the deltoid in elevating the arm. (2) The section is made within the capsule, after, of course, freely opening this, but not damaging its attachments to the neck of the bone. (3) The tendons in the bicipital groove are less likely to be interfered with.

Mr. Davies-Colley (*Guy's Hosp. Repts.*, 3rd series, vol. xx. p. 525) relates a case of partial resection followed by unimpaired movement of the joint.

As at the time of the operation a portion of the head of the humerus seemed healthy, and the disease consisted chiefly of a carious erosion of the great tuberosity and the adjacent portion of the articular surface, these portions only were removed, without dislocating the head of the bone. The part removed was chiefly the articular surface above the greater tuberosity, together with what remained of that process. The lesser tuberosity appears not to have been touched. About three-fifths of the articular surface was left, being healthy. There was some erosion of the bone below the epiphysial line, but the greater part of the disease was situated in the epiphysis. The section of the bone was hard. Seven months later the movement of the joint was "perfect in every direction. He swings the arm round above his head, and rotates it, and performs every action with as great freedom and rapidity as with the left shoulder-joint."

If the disease extends lower down, gouging may be resorted

* Prof. Longmore (*loc. supra cit.*, p. 9) says that at one time there were at Fort Pitt two patients, in each of whom resection of the joint had been performed, in one by the longitudinal, in the other by the flap incision. In the former case, the patient could raise, without difficulty, $\frac{3}{4}$ hundredweight with the arm in an extended position by his side, and hold 14 pounds in his hand when the arm was flexed. In the latter case, all the movements of the joint were very seriously impaired. The man could not, in any degree whatever, move the arm from the side himself, nor could he flex the forearm upon the upper arm without support from the other hand.

to, or, if needful, one or two further sections* may be made till healthy tissue is reached, but, as in the case of the elbow, periosteal deposits or roughenings, which will subside when the irritation is removed, must not be mistaken for disease which calls for extirpation.

The glenoid cavity is then examined, and gouged if carious. Cases where its complete removal is called for must be most rare. If really called for, it may be effected by an osteotome, or by

FIG. 65.



The above represents a fair average amount of movement, such as may be expected after excision in children in whom the securing of adequate active and passive movement is always difficult. The disease was tubercular mischief in the upper epiphysis. Numerous sinuses were present in front and in the axilla.

cutting bone-forceps; but taking away the glenoid cavity must interfere with the attachments of the biceps and triceps, and cause risk by the opening up of additional cancellous tissue.

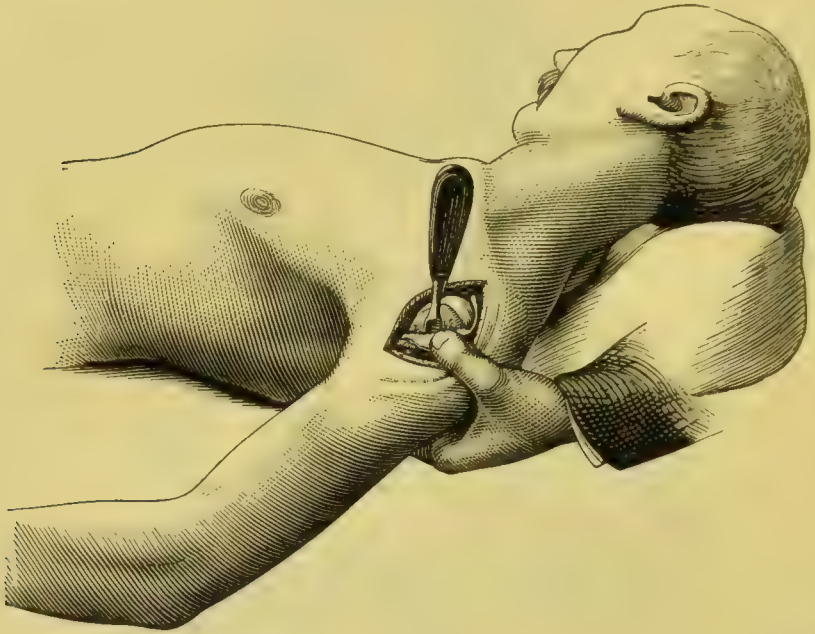
Any vessels which require it are then secured—*c.g.*, branches of the circumflex arteries. Sinuses are then examined, pulpy tissue scraped out with sharp spoons, drainage provided, and the upper part of the wound closed. It is well, in inserting the drainage-

* In cases of gunshot injury, splinters of head or shaft will have to be carefully removed, and the point determined whether the shaft is extensively split towards the elbow. This is often very difficult to determine, because a longitudinally fractured shaft may be maintained in an apparently unfractured condition by the close apposition of the fragments, and by the periosteum, &c.

tube, to make a counter-puncture at the back of the upper arm, so that the site of the operation may be well drained while the patient is recumbent.

The patient for the first few days should have his shoulder supported on a pillow, and wear a large pad, 5 to 6 inches thick at its base, in his axilla. By the end of the first week he should be sitting up, still wearing the pad, and after a fortnight, earlier if possible, passive movement should be begun. The fingers and elbow should be gently moved from the very first. Electricity, shampooing, encouraging the patient (if in a hospital) to sweep

FIG. 66.



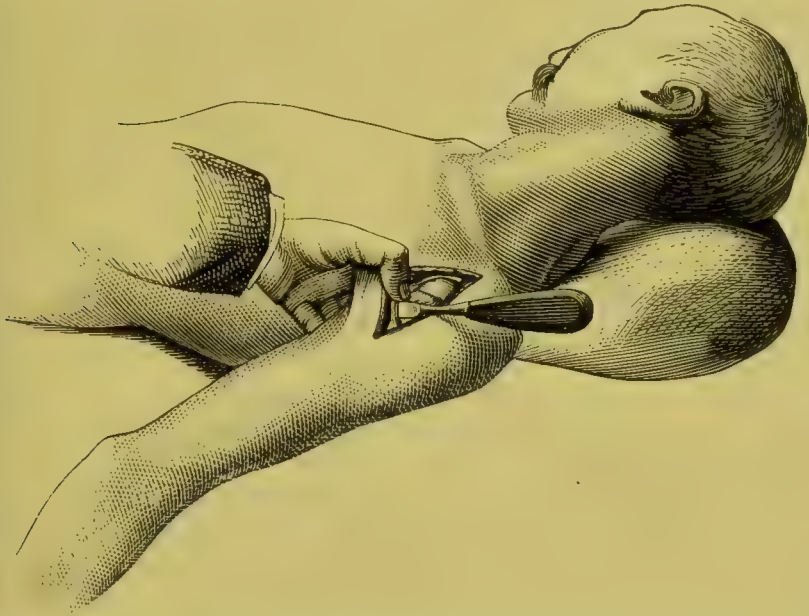
Separation of the periosteum from the great tuberosity, the arm being turned inwards. The blunt dissector is that of M. Farabeuf (Fig. 36). (Farabeuf.)

with a short brush, carry weights, constantly practise lifting the arm—anything, in short, which practises the patient in using the arm and new joint—should be perseveringly made use of.

QUESTION OF SUB-PERIOSTEAL RESECTION.—As one of the chief drawbacks of the operation is the poor amount of abduction and elevation which remains, owing, in large measure, to the humerus being too short to be brought into the glenoid cavity when the deltoid acts, I think that in this joint a trial of the sub-periosteal method should be carefully made, to insure as much reproduction of bone as possible. Mr. Holmes (*System of Surgery*, vol. iii. p. 741), it is true, does not have a high opinion of this method. "I do not find any clear proof, in the recorded experience of operators who practise sub-periosteal excision, that more extensive movement is obtained after that than after the ordinary method.

Nor does it seem probable that it should be so. The power to elevate the arm above the horizontal line depends on the rotation of the scapula, which carries with it the humerus, the two bones being for the moment consolidated in consequence of their perfect apposition in the joint. When the joint is destroyed, and a ligamentous connection between two irregular bony surfaces has been substituted for it, such a consolidation is impossible, and the rotation of the scapula will no longer elevate the humerus. Unless we could believe that the globular head of the humerus were reproduced, we could not expect that the power of elevation would be regained. M. Ollier speaks as if this reproduction were the normal result of sub-periosteal resection, but he refers to no dissection." Urging, as I would very strongly, the importance of

FIG. 67.



Separation of the periosteum from the lesser tuberosity, the arm being turned outwards. (Farabeuf.)

giving the sub-periosteal method a full trial in this excision, I would point out that M. Péan (*loc. supra cit.*, p. 51 *et seq.*) quotes Textor as finding, eleven years after an excision of the shoulder, "a new fibrous capsule. This, hard and, as it were, fibro-cartilaginous, surrounded, by its inner surface, the upper fourth of the humerus, and embraced it so firmly as to be separated with difficulty; by its outer face it was blended, by the intervention of fibrous tissue, with the structures surrounding the joint, and particularly with the deep surface of the deltoid and the cicatrix in the soft parts." Allusion has already (p. 68) been made to the completeness of the result which may be met with after excision elsewhere. Von Langenbeck (*Arch. f. klin. Chir.*, 1874, vol. xvi.)

gives more than one case in which the arm could be raised vertically, and the movements were excellent. While it is true that these were cases of resection for gunshot injury, and therefore the patients probably healthy adults; on the other hand, preservation of the periosteum is not likely to be so easily effected here as in those cases where it is softened by disease. Even if the periosteum cannot be completely preserved, an additional $\frac{1}{2}$ inch or inch in length gained, and an irregular knob or nodule-like mass which may be moulded into a rudimentary head within the new capsule, may make much difference in the future mobility and usefulness of the limb.

The following are the chief steps of the sub-periosteal method (Farabeuf):—The arm being in the position given at p. 138, and the deltoid divided, the position of the bicipital groove is made out where it lies between the tuberosities, and an incision is made a little outside the groove through the capsule and the periosteum of the great tuberosity as far down as the intended bone-section. With a periosteal elevator the lips of the capsulo-periosteal wound are then peeled off as far as the external and internal tuberosities respectively. The left thumb or a retractor keeps the soft parts back. The biceps tendon should lie safe in the inner lip of the wound. The head of the humerus should only be dislocated sufficiently to expose the level at which it is intended to apply the saw. A slightly curved elevator (Fig. 36), and an assistant who will aid the operator by abducting or adducting, rotating in and out, and pushing up the head of the bone as needed, will be found most helpful. If ankylosis is present in a shoulder it is proposed to excise, and too firm to break down, the union should be divided by a chisel and mallet.*

AMOUNT OF BONE THAT MAY BE REMOVED.—This will mainly depend upon the amount of damage done to the periosteum, the possibility of retaining it entire, and the age of the patient.

Dr. Maclaren (*Lancet*, June 7, 1873) removed the head and $3\frac{1}{2}$ inches of the upper end of the humerus with an excellent result.

Langenbeck mentions a case in which the whole shaft of the humerus necrosed.

This was removed, the elbow-joint being resected at the same time, and yet the reproduction of bone was so complete that the shortening was no more than $1\frac{1}{8}$ inch. The patient was young, and growth went on, though the bone remained behind its fellow. The new humerus broke several times, but the movements of the shoulder and elbow were very satisfactory, and the hand was capable of most delicate movements.

Prof. Billroth (*Wien. Med. Blätt.*, March 20, 1884; *Lond. Med. Rev.*, 1884, p. 197) gives the case of a patient, aged twenty, in whom the whole of the right humerus was removed when he was twelve.

* See also Ollier, *Traité de la Régénération des Os, et des Résections des grande Articulations*, 1867.

Though the periosteum was carefully left intact, the bone did not form again. Yet the forearm was well developed, and, by means of an ingenious splint and an artificial shoulder-joint, the patient could use his arm and hand well.

(*Cf.* the remarks on excision in continuity of the shaft of the humerus.

Excision of Shoulder in Military Surgery.—The following points of practical importance are taken mainly from the *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 519 *et seq.* Dr. Otis here draws conclusions from the histories of 885 cases, 670 being for direct injury, and 215 for fractures in near proximity to the joint or for consecutive caries or necrosis.

Excision of the head of the humerus, together with portions of the clavicle and scapula—*c.g.*, acromion, spine, coracoid process, glenoid cavity—was performed in forty-two cases.

It is remarkable that the mortality is less in this group than in that of simple removal. The following remarks are quoted from Lœffler:—Fracture of the glenoid cavity is especially frequent in shot injuries of the shoulder. This complication makes the prognosis of excision more serious, but is not a contra-indication. If only fissures are present, the glenoid cavity should not be removed. Tedious burrowing of pus is very likely in these cases.

Partial excision of the head of the humerus was done in fourteen cases.

The results do not prove that, when the head of the humerus is grooved or grazed by a ball, it is safer to slice off the injured part rather than to decapitate the bone. Ankylosis was too frequent to permit much to be said in favour of partial excision in this region.

Date of excision of shoulder.

The *primary* cases were 273, the *intermediate* 55 in number, the results being far less satisfactory than in the primary, "and corroborating the general rule forbidding operations during the inflammatory stage after injury, except under circumstances of exceptional urgency." The mortality was twice as great as in the primary, and nearly 12 per cent. greater than in the following. *Secondary*, twenty-six cases, with a mortality of 50 per cent. The greater success of primary excision can well be understood. The condition of the soft parts is much more favourable. There is no infiltration or burrowing of pus, no softening of parts or degeneration of muscles, no caries or osteitis—none, in fact, of those complications which, in secondary excision, imperil the life of the patient and usefulness of his limb.*

* Dr. Otis quotes Rupprecht, one of the German authorities in the war of 1871, to the same effect:—"The secondary operations were very much aggravated by deformities, gradually appearing after the injury, through thickening of the periosteum especially, and by extensive cavities succeeding abscesses. Immediately after the operation even, healing was retarded by pus-formations, sometimes under the clavicle, in other instances under the scapula, again on the anterior aspect of the arm. Aside from the greater muscular atrophy due to debility resulting from antecedent, tedious suppurations, and to pain and loss of sleep; apart, also, from the abundant granulations attending secondary operations, and resulting prejudicially in regard to the future usefulness of the limb, the disadvantages of secondary operations already adduced were of sufficient importance to permit us to declare that primary resection of the shoulder-joint is preferable to the secondary operation."

Excisions of the head and portions of the shaft of the humerus as well, 293 cases, in 190 of which the precise length of bone excised was specified.

Thus, in twenty-three, 4 inches ; in eleven, $4\frac{1}{2}$; in seven, 5 ; in two, $5\frac{1}{2}$; and in five, 7 or 8 inches were excised. While the arm was shortened (there being very rarely any restoration of bone) and feeble, the forearm and hand were usually most useful. Where the arm was flexile and uncontrollable, an auxiliary apparatus, such as the ingenious ones of Dr. Hudson,* brought about usually a great improvement.

Dr. Otis (*loc. supra cit.*, p. 611) states of shot-injury resections:—"In the majority of cases that I have examined, motion in flexion, extension, and adduction was tolerably well preserved. I have met with no instance of true ankylosis. In a large proportion of the cases, the functions of the forearm and hand were but slightly, and in many not at all, impaired. Those who argue that the limb is useless after an excision at the shoulder because it dangles by the side, display a superficial appreciation of the considerations to be taken into account. Apart from the inestimable value of even a partial use of the hand, the mere weight of the limb, though its motor functions be completely destroyed, is of advantage in preserving the equilibrium of the body and avoiding the distressing deformity consequent on ablation."

* *Loc. supra cit.*, Figs. 449, 453.

CHAPTER VII.

REMOVAL OF THE SCAPULA.

Indications.

1 New growths. 2. Caries. 3. Accidents—*e.g.*, railway and machinery accidents.

As it is the first of the above which chiefly raise the question of removal of the bone, and which present the greatest difficulties, it is to removal of the scapula for new growths that most of the following remarks will apply.

A. Partial Removal of the Scapula.—In a very few cases (*e.g.*, for a simple exostosis, or where the surgeon is certain that he is dealing with an unmixed enchondroma in an early stage) a more limited operation may be sufficient. The chief essential points here are—(1) to freely expose the growth by appropriate flaps, so that the limits may be clearly defined; (2) to be provided with reliable instruments of keen temper, owing to the exceeding hardness which may be met with here.

While some Continental writers* have given elaborate directions for partial removal of the scapula, it is only in the above very few cases that this operation is likely to be used by English surgeons. Mr. Pollock, in his paper† on two cases of removal of the scapula, thus advises on this matter: "If a portion of the scapula be removed, it should only be the lower portion. But even if this be attempted, the loss of blood would probably be much greater than if the whole bone were removed; for the wound is more confined, and the wounded arteries are more apt to retract behind the bone above, and offer great obstacles to their being secured. However, should the lower angle be alone the seat of disease, the attempt to remove the lower portion only is justifiable." It must, however, be borne in mind that, when a bone is once the seat of disease which requires removal, the disease is very apt to recur in the portion left, and less liable to do so if the whole bone be removed.

The above remarks of Mr. Pollock are entirely borne out by the histories of cases which have been watched after partial removal of the scapula for any growth save an exostosis.

Thus, in January 1865 Sir W. Fergusson (*Lancet*, vol. ii. 1865, p. 591) removed the lower two-thirds of the scapula for a sarcomatous growth. Recurrence took

* *E.g.*, M. A. Demandre, *Des Tumeurs de l'Omoplate* (Paris, 1873).

† *St. George's Hosp. Reports*, vol. iv. p. 236.

place, and, in the following November, the rest of the scapula, the greater part of the clavicle, and the upper extremity were taken away.

Dr. Bird, of Stockport (*Lancet*, vol. ii. 1865, p. 696), removed the lower two-thirds of the scapula for a growth the size of an orange in the infra-spinous fossa, in a child aged ten, the bone being sawn through behind the neck in a line with the supra-scapular notch. A year and a half later the growth recurred and grew quickly, the rest of the scapula being now taken away together with the head of the humerus, which had become adherent to the scapula, and thus also required removal. A year and a half later the child remained well, the use of the hand "in sewing and writing being very little impaired."

B. Removal of the Entire Scapula by itself (*e.g.*, cases where the growth is primary from the scapula, and where there is no extension to the humerus or into the axilla).—Preparations against shock should be taken, the extremities being bandaged in cotton-wool, the head kept low, ether given, and subcutaneous injections of ether and brandy, and the materials needful for infusion of saline solution (p. 86) being in readiness. The patient is placed at the edge of the table and rolled over to the opposite side. If the growth is very vascular, the patient weakly, pressure on the subclavian is of importance, or if, from the extension of the growth this is rendered difficult, it may be effected by making an incision down to and through the deep fascia over the artery itself, in order to enable an assistant to put his thumb or finger directly upon it.* This may be done by a separate incision, or by an extension of that by which the clavicle is divided.

Flaps are quickly and freely turned back, usually by a T-shaped incision, one limb running from the acromio-clavicular joint inwards to the superior angle of the scapula, while the other and longer is made at right angles to the first down to the angle of the scapula. In another case the surgeon may prefer to make an incision along the vertebral border of the scapula, and the other at right angles to it across the centre of the growth.† In either case care must be taken not to open the capsule of the tumour.

When the whole mass is thoroughly exposed, the trapezius and deltoid are first severed, the arm being pulled away from the trunk. The subclavian being now firmly compressed, the levator anguli and the rhomboidei are cut through,‡ the posterior scapular artery

* As adopted by Prof. Syme in performing the old operation in a case of axillary aneurism, p. 113. If the clavicle is going to be removed, the subclavian can be commanded by cutting down on the clavicle, freeing it from its attachments in its inner third, passing a flat director carefully beneath it, sawing through the bone here, and removing a portion of it, the finger being thus placed directly on the subclavian (Jeaffreson, *Lancet*, 1874, vol. i. p. 759).

† If the skin is involved or ulcerated, the flaps must be so shaped as to isolate this.

‡ It is a bad sign if any of the muscles severed are infiltrated with growth. That this, however, is not incompatible with a good recovery is shown by the second of Prof. Syme's cases (*Excision of the Scapula*, p. 28), in which it is stated that "the tumour weighed between 4 and 5 pounds: it had a soft consistence and very suspicious aspect, which was strengthened by microscopical

secured, and the serratus magnus divided, being first made tense by lifting the scapula off the ribs upwards and outwards. The muscles on the upper border are next* attacked—viz., any remains of the deltoid, the omo-hyoid, and the supra-spinatus—and the supra-scapular artery secured. The acromio-clavicular joint is next opened, or else the acromion or clavicle,† according to the extension of the growth in this direction, severed by bone-forceps or a narrow saw. If the acromion can be safely left, the resulting deformity—viz., dropping of the shoulder and entire loss of trapezius action—will be lessened.

The lower angle and the latissimus dorsi (if involved) being freed, the scapula can now be dragged away from the chest by slipping two or three fingers over the upper or vertebral border. Thus, by tilting the scapula outwards, the axillary border can be inspected, the teres and infra-spinatus muscles severed, the position of the sub-scapular artery defined by a finger passed beneath it, and this vessel secured, if possible, before it is cut. The scapula being still further pulled away from the chest, the muscles attached to the coracoid process are next severed, and the scapula removed by cutting into the shoulder-joint and severing the capsular tendons and the biceps and triceps. The coracoid process may become detached at this stage if partially eroded by extension of growth, or if the patient be a young one. If this happen, it must be carefully dissected out afterwards.‡ The main arteries must be secured before they are cut. Too many Spencer Wells's forceps must not be left on at one time, or they will be found to interfere

examination, as the muscular substance that was taken away along with the growth appeared to be loaded with the germs of future disease; but fifteen months having elapsed since the operation was performed, without the slightest appearance of relapse, it may be hoped that the recovery will prove permanent." On this point I would refer my readers to the case of mine at p. 151.

* If the upper border can be taken before the axillary one is dealt with, the subclavian can be better controlled when the sub-scapular artery (a source of free hæmorrhage) is severed.

† Prof. Spence (*Ed. Med. Journ.*, August 1872, p. 178) recommends that the clavicle should be left, not sawn through, otherwise the head of the humerus tends to project through the incision, there being nothing but skin left, the overhanging arch of bone having been removed. On the other hand, sawing the clavicle, while it leaves a cut surface of bone as a possible source of irritation, facilitates the operation somewhat, as it exposes better the large vessels and the muscles attached to the coracoid process.

‡ If the growth has involved the axillary vessels and nerves, this outlying portion may be dealt with later on, after the main mass has been separated and removed. If it is desired to remove this extension of the disease now while in continuity with the scapular growth itself, the surgeon will have both his hands free for what is a troublesome dissection, by asking an assistant to drag the main mass strongly backwards. To facilitate this step, Prof. Syme (*loc. supra cit.*, p. 26) placed a piece of cord round the divided extremity of the clavicle, for the assistant to pull upon. The greatest care must be taken, when dealing with projections into the axilla, to keep the knife, or blunt dissector, very close to the growth, for fear of opening the large vessels.

with the needful manipulating of the bone. Every vessel must be thoroughly secured when it is severed; otherwise, oozing is very likely to take place a few hours later.*

Hæmorrhage may be best avoided by attention to the following points:—(1) Adequate pressure on the subclavian, this being effected by a special incision, if needful, to command the vessel. (2) Taking care not to cut into the growth itself. (3) Dealing with the axillary border and sub-scapular artery last. (4) Rapid use of knife or scissors by the operator, aided by intelligent help from assistants in securing bleeding points, and from an anæsthetist, who will not be unduly anxious. (5) By some it is recommended to make the incisions gradually, not larger than are required at the time, as a means of minimising the hæmorrhage. It must be remembered, with regard to this point, that small and cramped incisions interfere with a free and rapid hand and sufficient exposure of the parts, conditions which conduce to thorough dealing with bleeding points, and thus facing one of the chief difficulties of this important operation.

Adequate drainage is now provided, the flaps united, and the arm secured to the side for a few days, after which it may be supported in a sling if the head of the humerus does not tend to protrude.

In the case of sarcomata, removal of the scapula alone or together with the upper extremity (chap. viii.) may be called for.

The malignancy of these growths is well known, together with their tendency to involve surrounding parts and to creep into regions inaccessible to the surgeon. Early operation is imperatively required.

In the case of operation, the prognosis will be best, however large the growth, when the rate of progress has been slow, when the growth is uniformly hard, or if only a certain amount of elasticity is combined with the hardness (as in unmixed enchondromata), when the outline is distinct and well defined, and the mass movable upon the ribs.†

On the other hand, the prognosis is less favourable when the outline is uniform rather than nodulated or bossed, the feel semi-elastic instead of hard, the progress rapid and painful, the different parts of the scapula much obscured‡ and its mobility much

* In a case of this kind, Mr. Berkeley Hill transfused twice, but unsuccessfully, the patient dying of shock and acute septicæmia, in forty-five hours (*Brit. Med. Journ.*, 1880, vol. i. p. 487).

† That this mobility is a matter of some importance is shown by the following case, quoted by M. Sédillot at p. 550 of his *Traité de Médecine opératoire*: "Nous refusâmes un jour d'opérer un jeune homme atteint d'un cancer énorme du scapulum, dont les limites n'étaient pas nettement fixées, et nous dûmes nous applaudir de notre abstention en découvrant plus tard, à la nécropsie, que la tumeur avait pénétré dans la poitrine et envahi un lobe pulmonaire."

‡ In a very large scapular sarcoma on which Mr. Pollock operated, it is stated that "the mass extended over the upper portion of the scapula, which could not

impaired, the outline of the growth ill defined and lost indistinctly in the axilla. Pulsation, bruit, enlarged glands, and infiltration of the skin are also of evil omen.

CONDITION OF THE LIMB AFTER REMOVAL OF THE SCAPULA.—A limb thus preserved will be strong and useful. If the clavicle has not been much interfered with, the clavicular fibres of the deltoid will remain, and these, together with the latissimus dorsi and pectoralis major, will probably confer a fair amount of motion on the limb. In one of Prof. Syme's cases, after removal of the scapula and the outer third of the clavicle, and by a previous operation, the head of the humerus, the patient was able to lift heavy weights, and to fill the appointment of provincial letter-carrier.

In a very successful case of Mr. Symonds' (*Clin. Soc. Trans.*, vol. xx. p. 24), in which the scapula was removed for osteosarcoma, the man was in good health two years and a half after the operation.

He was able to do all the lighter work of a carpenter, including the use of a plane. Overhead work he could not do. In this case the articular surface of the humerus had also been removed about a month later, as it was thought to be the cause of prolonged suppuration.

The following case is of interest from the extension of the sarcoma into one of the scapular muscles, the ill-defined outline and soft feel of the growth, its long duration, and yet the long period of relief which has followed:

In March 1892 one of the nurses at the Canterbury Hospital was sent to me by Dr. Alexander, of Faversham. The outline of the left scapula was replaced by a large mass of uniform outline, fairly defined over the lower two-thirds of the bone, but above very indistinct, semi-elastic to the feel, without any nodules or bosses of harder growth. The scapula was movable upon the ribs. The history was one of early pain eight months before, for which the patient used to resort to the baneful remedy of rubbing her scapular region against any hard projecting ridge, *e.g.*, a mantelpiece. For the last three months the increase in the size of the swelling and in the pain had, alike, been rapid. The scapula was removed in Bright Ward, and I am particularly indebted to Dr. H. Hodgson, now of Blisworth, for the masterly way in which he administered the ether. The most interesting point about the case was that the sarcoma, which appeared to have begun in the infra-spinous fossa, had perforated the bone, and in many places greyish masses of growth could be seen blending with and replacing the delicate fasciculi of the sub-scapularis. The chief difficulty met with in the after-treatment was keeping the patient, a highly neurotic woman, and one not amenable to treatment, quiet. The wound did not run an aseptic course. Ten days later incisions were required for drainage of the suppuration which followed. Later on the articular surface and epiphyses of the head and tuberosities of the humerus became detached. Two years after the operation I saw the patient. The antero-posterior movements of the shoulder-joint were good. The patient could nurse a delicate mother, use her needle, &c., but abduction and elevation

here be traced, and over the outer part of the clavicle, which could not be felt; and also so far into the lower triangle of the neck that the subclavian artery could not be distinguished or reached by the finger." The whole mass was removed but the patient, aged forty-seven, died on the sixth day, of chronic bronchitis.

were almost completely abolished. In spite of the infiltration of one at least of the muscles, there was no evidence whatever of any recurrence.

Age of the Patient.—It may be not uninteresting to some to know that the scapula has been successfully removed for growth at ages varying between “about seventy” and “about eight.” The former was a patient of Prof. Syme, who died about two months after the operation, apparently of internal deposits. The latter case occurred in India,* the upper extremity being removed at the same time.

Dangers of the Operation and Causes of Death.—These will be the same as those given at the end of the next chapter.

2. Removal of the Scapula for Caries.†—This needs no especial mention. The parts being sufficiently exposed, the operation will be conducted, as far as possible, sub-periosteally, by means of appropriate blunt dissectors or periosteal elevators.

* A very brief mention of this case is given in a letter, *Lancet*, 1874, vol. i. p. 819. It is not stated whether the patient was a native or no.

† A good case of this kind is recorded by Sir W. Fergusson (*Med.-Chir. Trans.*, vol. xxxi. p. 310). An exquisite drawing of the scapula—one of the very best by the hands of the Baggs—will be found in the same author's *Practical Surgery*, 4th ed. p. 309, Fig. 144.

CHAPTER VIII.

REMOVAL OF THE UPPER EXTREMITY, ARM, SCAPULA, AND GREATER PART OF THE CLAVICLE.

INTERSCAPULO-THORACIC AMPUTATION.

THIS operation, performed chiefly for growths which cannot be completely removed by amputation at the shoulder-joint,* and much more rarely for injury, has been of late years advocated by M. Paul Berger (*L'Amputation du membre Supérieur dans la contiguité du tronc*, Paris, 1887) amongst Continental surgeons, and by Mr. Treves in this country.

The method described below is that of M. Berger; a very clear account is that given by M. Farabeuf (*loc. supra cit.*) and Mr. Treves (*Oper. Surgery*, vol. i. p. 397) on which I have drawn largely.

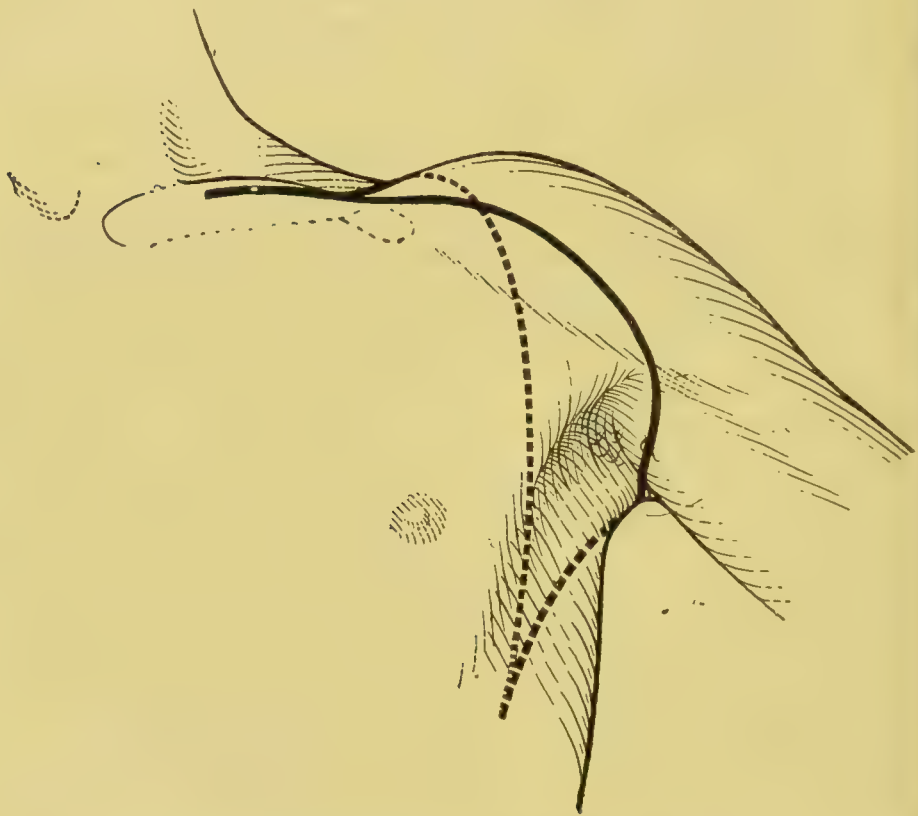
First Step.—Division of the clavicle and securing the vessels. The patient being brought to the edge of the table, with his shoulders raised, the surgeon, standing outside the limb, makes an incision with a stout scalpel along the whole length of the clavicle, from just outside the sterno-mastoid muscle to a point immediately beyond the acromio-clavicular joint. The incision divides the periosteum down to the bone over the middle portion of the clavicle. At this stage, venous oozing from the large superficial veins here met with may be very free. With a curved elevator (Fig. 36) the periosteum is separated from the middle portion of the clavicle.† A large blunt hook (Treves) or a blunt dissector being passed under the inner end of the bared part of the clavicle, this is sawn through with a narrow or chain-saw. The same part of the clavicle being now raised and steadied with lion-forceps, and the periosteum

* Any surgeon in doubt as to the necessity of submitting his patient to so severe an operation, should begin by an incision between the deltoid and pectoralis major, and then, when the muscles are thoroughly retracted, examine the condition of the axilla, the glands, and whether the large vessels and nerves are embedded in the growth, &c.

† This preliminary detachment of the periosteum was recommended by Prof. Ollier as a safeguard against wounding the vessels. Mr. Chavasse (*loc. infra cit.*) says that "practically this step is not to be recommended, as the periosteum left obscures the subclavius muscle, and has to be immediately divided."

completely separated from its under surface, the bone is again divided at the outer end of its middle third. The exposed subclavius with its sheath is now isolated and cut through close to the site of the inner section of the clavicle, dissected up so as to expose the large vessels, and turned outwards.* Fasciæ of varying thickness will have to be divided before the vessels are reached (Treves). During this step the upper border of the pectoralis minor should, if possible, be defined; the surgeon must be prepared for troublesome bleeding from the cephalic vein and

FIG. 68.



Interscapulo-thoracic amputation. Outline of the flaps (left side). The posterior or cervico-scapular is shown dotted. (Farabeuf.)

branches of the acromio-thoracic vessels, and he may find a guide recommended by Berger—viz., the external anterior thoracic nerve, easy to see or feel. This nerve, if followed upwards, leads to the interval between the artery and vein.† These large vessels are then secured and divided between double ligatures of carefully sterilised silk, pushed well apart in each case, and tied very securely before each vessel is cut. The ligatures should be placed upon the subclavian vessels themselves, at a point to which the tubercle on the first rib will be a guide. If possible the artery should be

* The subclavius must be thoroughly divided in order to obtain room for securing the vein.

† Careful feeling for the pulsation of the artery will be another aid.

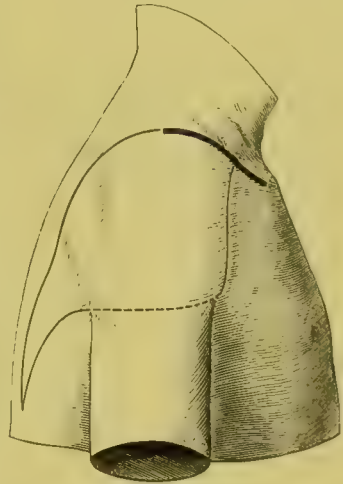
secured first, so that as little blood as possible be left in the extremity (Treves). This step will lessen the size of the vein and render the securing of it less difficult; furthermore, as pointed out by Prof. Keen, if the vein be injured, as happened in his case, while it is being tied, the wound will not be flooded with blood. If, however, the vein be so much distended as to obscure the artery, the former vessel must be taken first. In either case the greatest care must be taken not to injure this vessel for fear of air entering the circulation. If any such accident occur the spot must be instantly closed, and the wound flooded with some weak aseptic lotion. While exposing the vessels, the supra-scapular vessels will probably be seen crossing the upper part of the wound, and should be secured.

Second Stage.—Formation of the flaps. These are pectoro-axillary and cervico-scapular, and, in fashioning them, the surgeon must be guided by the extent of the disease. The patient being so placed and steadied that the whole of the scapular region is free of the table, and the surgeon standing between the limb and the trunk, the pectoro-axillary flap is then traced as in Figs. 68 and 69. As there shown it commences in the centre of the incision over the clavicle, runs downwards and outwards just above the coracoid process, and then parallel with, but a little external to, the depression between the deltoid and pectoralis major. On reaching the point where the anterior wall of the axilla and the arm join, the knife is carried over the lower edge of the pectoralis major across the axillary aspect of the arm (Fig. 68), and then backwards and downwards (the limb being well raised by an assistant)

so as to pass over the lower edges of the latissimus dorsi and teres major and end over the apex of the scapula (Fig. 69). The above incision only divides skin and fasciæ. The pectoralis major is next cut, and the pectoralis minor found and severed near the coracoid process. The top of the axilla being now well opened up, the cords of the plexus are divided at the same level as the large vessels, great care being taken of the central ligatures on these, the patient being rolled over on to his sound side, and the limb drawn across the chest. The cervico-dorsal flap is next made by drawing the knife from the outer extremity of the clavicular incision, straight back over the spine of the scapula to the lower angle of this bone, where it meets the first incision. The skin and fascia divided by this incision are reflected to the vertebral border of the scapula.

Nothing now remains but the *third and last stage*—viz., the

FIG. 69.



Interscapulo-thoracic amputation (right side). (Keen.)

removal of the limb. This is effected by the division of the trapezius, omo-hyoid, levator anguli, rhomboids and serratus magnus. While these muscles are severed the flaps are well held back, and the limb suitably manipulated, partly by an assistant and partly by the left hand of the operator.* During this stage the posterior scapular certainly, and the supra-scapular, if not secured before (p. 155), will require ligatures. But of course the mere mention of normal arteries gives no idea of the number that will be met with, veins as well as arteries, enlarged in cases of new growths. This makes it all the more important to secure first the subclavian artery and vein.

The flaps and all the recesses of the large wound are most carefully scrutinised for any evidence of infiltration or extension of new growth. The condition of the glands in the posterior triangle should also be investigated.

Dangers of the Operation and Causes of Death.—These are :

1. Hæmorrhage. This may be met with from the main trunk, the branches of the axillary, and the enlarged anastomosing veins in cases of growth. The first two of these dangers and the third, to a larger extent, will be met by tying the subclavian vessels after Berger's method. This also prevents entrance of air into the large veins, allows of section of vascular muscles like the great pectoral with scarcely any blood, while division of the posterior muscles, where the arterial supply has not been cut off, is reserved for the last step of the operation. If, after resection of the clavicle, it is found impossible to secure the third part of the subclavian vessels owing to the profuse venous oozing, or from the displacement of the parts from invasion by the growth, Mr. Chavasse advises proceeding at once to make the upper part of the anterior flap, dividing the two pectoral muscles, and, after fully exposing the first part of the axillary vessels, tracing these up to the scalenus anticus and tying the subclavian artery and vein.† Other courses open are to tie the subclavian vessels in their third part in the usual way. Dr. Joseph Bell (*Man. of Surg. Operations*, 6th ed.), secured the hæmorrhage by a "skewer"

* The humerus, if much invaded by growth, may, here, give way.

† Mr. Chavasse, in his case (*Med.-Chir. Trans.*, vol. lxxiii. p. 81), being unable owing to free venous oozing, to tie the subclavian vessels, divided the first part of the axillary vessels between double ligatures. Profuse arterial hæmorrhage followed on the seventeenth day from the lower part of the wound which was granulating—it is not stated whether the healing had been aseptic throughout. The second part of the subclavian artery was tied, and the patient made an excellent recovery. Prof. Keen (*Amer. Journ. Med. Sci.*, June 1894) met with great trouble in securing the subclavian vein. "A large vein under the inner sawn end of the clavicle tore, and gave me much trouble, but finally, partly by : ligature round the tissues, in which lay the vein, and partly by a ligature which was applied temporarily round the tissues and around the sawn end of the clavicle in a groove sawed in the bone, so as to prevent the slipping of the ligature I was able to control it." Another most instructive case is given by Prof. Keen *Annals of Surgery*, June 1895.

passed under the clavicle and vessels and a rubber cord looped round.

2. Shock. This will be met by taking every step to prevent hæmorrhage,* emptying the limb of venous blood before the vein is tied, keeping the body warm, administering ether, and completing the operation as speedily as possible. Afterwards infusion of saline fluid (p. 86), should be resorted to, if other methods—*e.g.*, subcutaneous injection of strychnine, ether or brandy, enemata of port wine and beef-tea, and firm bandaging of the limb are insufficient.

3. Septicæmia. This is a very probable danger, if the flaps (perhaps left needlessly full) slough, or if retention and bagging of discharges are allowed to occur in the large cavity which will be present in the stump, unless this is obliterated by pressure, or that which is left sufficiently drained.

4. Entrance of air into veins. This very nearly proved fatal in a case in which Mr. Jessop, some years ago, removed the scapula, outer half of the clavicle, and the upper extremity (*Brit. Med. Journ.*, vol. i. 1874, p. 12).

In this case the scapula seems to have been removed owing "to considerable deficiency of cover" after removal of an upper limb much damaged by a machinery accident. "Whilst cutting through the last attachments of the scapula, two distinct loud whiffs were heard, caused by the rush of air into the subclavian vein." The operation was completed while artificial respiration was being performed, and the lad recovered.

5. Recurrence. While the results of this severe operation are, as far as immediate recovery goes, good, recurrence, in the case of periosteal sarcomata, takes place, as a rule, within six or twelve months. Thus out of forty-three cases in which the operation was performed for the removal of new growths, thirty-four recovered: of these the result is uncertain in ten. In fourteen recurrence took place, and in eleven of these within the year. Occasionally, in the case of the firmer and slower growths especially, viz., enchondromata, osteo-chondromata, it may be advisable to attack the recurrence.

In a case of Mr. Heath's (*loc. supra cit.*), recurrence took place seven months after extirpation of arm and scapula in a lad aged sixteen, with two years' history of the growth, an "osteo-sarcoma." The recurrent growth was removed, but two years and a half after the original operation recurrence again took place, and was dealt with about five months later. A rapid recovery took place, and at the time of this, the latest operation, no signs of extension to the internal organs could be detected, and the patient was in robust health.

6. If the patient survive, an artificial limb should be fitted at an early date. It may not admit of active usefulness, but it will be of service in preventing the feeling of most irksome lopsidedness which in the convalescence and early getting about causes these patients so much difficulty in balancing themselves.

* In a case of this operation for an osteo-sarcoma in a woman of twenty-four, Mr. Macnamara (*Lancet*, vol. i. 1878, p. 667) was unable to find the subclavian artery after removal of part of the clavicle. The hæmorrhage during the last stage of the operation was very great, and the patient sank on the following day.

CHAPTER IX.

OPERATIONS ON THE CLAVICLE.

REMOVAL OF THE CLAVICLE.

REMOVAL may be required for new growths or necrosis. In either case it is but rarely called for. That for necrosis differs in no way, save for the importance of surrounding parts, from the same operation elsewhere.

Removal of the Entire Clavicle for New Growths.—The following account by Mr. Bowreman Jessett (*Lancet*, vol. i. 1889. p. 1077) of a case in which he removed the entire clavicle for a large sub-periosteal sarcoma, shows well the sort of operation required, and the difficulties likely to be encountered :

The patient was a girl aged sixteen : the growth was of more than a year's duration, and extended over the inner two-thirds of the clavicle. The following were the most important points which led the surgeon to recommend operation : The age of the patient. The fact that the growth, as shown in an illustration which accompanies the paper, extended much farther on to the chest wall than it did into the neck. It had originated on the front of the clavicle, and had only quite lately caused any pressure on the vessels. The skin was not implicated ; while complete removal was doubtful and attended with much risk, if left, the growth must inevitably have been fatal, and, from pressure on the large nerves, attended with great pain.

A — shaped incision was made, the long limb along the clavicle and the shorter one over the sterno-clavicular joint and growth. Flaps being reflected, the muscles were detached from the bone as far as possible, and the outer fibres of the sterno-mastoid divided on a director. A metal spatula was next passed behind the bone at the junction of the outer and middle thirds, and the bone divided here with a narrow saw, the section being completed with bone-forceps. The inner fragment was then pulled forwards with lion-forceps, while the subclavius* was carefully detached with scissors curved on the flat. Some

* In Prof. Mott's case (*Amer. Journ. Med. Sci.* (O.S.), vol. iii. p. 100) the subclavius could not be seen, being incorporated with the diseased mass. This greatly increased the difficulty of keeping above the subclavian vein. This vein was firmly adherent to the growth, but was finally detached by the most cautious use of the handle and blade of the knife alternately. The patient lost from 1 to 20 ozs. of blood, but made a good recovery. The growth was an osteo-sarcoma the size of two adult fists. The autopsy, fifty-four years later, showed that $\frac{1}{2}$ inch of the acromial end had been left, the rest of the site of the bone being occupied by a ligamentous band. And the latter, no doubt, is the condition present in the other cases where the after use of the limb has been so good.

difficulty was met with in opening the sterno-clavicular joint, as this was overlapped by the growth.* A further extension of this over the top of the first rib made it difficult to divide the costo-clavicular ligament, which was effected with scissors after suitable dragging up and rotation of the fragment and growth. Care was taken to leave untouched the sternal head of the sterno-mastoid. The anterior and external jugular veins were divided between double ligatures. The outer part of the clavicle was then seized with lion-forceps and removed (a small portion of the periosteum at the extreme end being left) after division of the muscular and ligamentous attachments. There was very little loss of blood. The patient made a good recovery, and three months later "the movements were equally good with those of the opposite side." An equally good result was obtained by Prof. Mott, whose patient (*vide supra*) survived fifty-four years, his death being then not connected with the growth. The use of the arm is said to have been complete. In Mr. Travers's case, where three-fourths of the clavicle were removed, there was scarcely any restriction of the movements of the arm, one of the boy's amusements having been rowing on the Thames. Again, in a case in which the whole clavicle, save a small portion of the acromial end, was removed for a malignant growth, the man afterwards did not find the loss any hindrance, being able to act as a bricklayer's labourer and miner.

A good instance of *partial* removal of the clavicle is recorded by Mr. Bland Sutton (*Clin. Soc. Trans.*, vol. xxiv. p. 12). Here the acromial half was removed for a myeloid growth in a woman, aged twenty-six. The chief difficulties met with were, first, the tightness with which the bony capsule was tied down over the coracoid process by the coraco-clavicular ligaments, these structures requiring careful division with scissors. Secondly, the supra-scapular nerve ran in a shallow groove in the capsule of the tumour, and was reflected without injury. Nearly four years later there was no evidence of recurrence. A fibrous band united the remains of the clavicle and the acromion, and the patient could perform all movements of the extremity perfectly.

UNUNITED FRACTURE OF THE CLAVICLE.

While this condition is extremely rare, it is of such importance as to claim some notice here.

An excellent instance, most successfully treated, has been recorded by Mr. Barker (*Clin. Soc. Trans.*, vol. xix. p. 104):

A boy, aged twelve, was noticed soon after birth to have a fracture of the right clavicle, the cause of this being uncertain. Up to nine years of age the child had no inconvenience. He was then gradually more and more troubled with pressure on the brachial plexus, pain down the arm, and a tendency of the

* In a case of Mr. Caddy's, of Calcutta (*Med. Rec.*, Nov. 19, 1892), in which the inner two-thirds of the right clavicle were removed for a periosteal sarcoma, the pleura and innominate vessels were exposed in dissecting away a tongue of growth which passed down behind the manubrium. The patient recovered with perfect movement of the arm.

fingers to become stiff and fixed in a flexed position in writing, this condition soon amounting to one of painful spasm, rendering the writing quite illegible.

With a view of resecting the false joint, lifting the inner end of the outer fragment off the brachial plexus, and wiring it to the inner fragment, Mr. Barker operated as follows:

Observing all the details of the Listerian method of antiseptis, I made a semilunar incision, about 3 inches long, with its two ends on the clavicle, and its convexity downwards. This corresponded to the middle of the bone, having the false joint above its centre. The flap of skin so formed was turned upwards off the bone, and with it I dissected up some fibres of the pectoralis with the object of securing that the nutrition of the skin should not be disturbed by dividing its deeper vessels. The bone being thus exposed, a false joint was found between the broken ends, which were united by fibrous tissue. I now divided the outer end of the inner fragment obliquely in a plane running from within outwards, and from before backwards. The section was made with Gowan's osteotome, and was done very cautiously, so as to disturb the periosteum and soft parts as little as possible, and obviate all risks to the vessels running beneath the clavicle. I then placed the osteotome on the inner end of the outer fragment, and divided it in a plane corresponding to that of the section of the inner fragment. Here my first cut was too oblique, and I withdrew the blade of the saw; but the second was accurately placed and sacrificed less bone. I now lifted the inner end of the outer fragment off the brachial plexus, and placed its cut surface resting upon that of the inner portion of the bone. A silver wire was then passed through both ends from before backwards, and twisted firmly. This seemed to secure sufficient fixation of the two portions, and the ends of the wire were cut, and the twisted portion bent level with the bone. The skin was then united with ordinary carbolic catgut, the edges of the pectoral muscle having been first brought together with stitches of the same. A strand of catgut was also inserted between the lips of the wound for drainage. No blood to any amount was lost, and the wound was a dry one. I therefore dressed it with powdered iodoform and salicylic wool, considering the latter more elastic than gauze. Plenty of ordinary wool was added for padding, and over all a plaster-of-Paris bandage was laid on. This was applied over a webbed vest precisely as for spinal caries, and completely immobilised the arm and shoulder for the month during which it was worn. To this perfect fixation of the parts concerned, quite as much as to the accurate apposition of the cut surfaces of the bone, the good result of the operation is, in my opinion, to be ascribed.

The dressings were not disturbed for fourteen days, when the wound was found united by first intention, except at one point where the catgut drain was still unabsorbed. There was not a drop of pus anywhere. A similar dressing was applied, and not removed for fourteen days, when all healing was complete. The plaster corset was then removed, and a mass of callus could be felt at the seat of operation. A week later the power of writing was found to be much improved, and the arm became perfect in all its functions.

Mr. Pollard (*Brit. Med. Journ.*, vol. i. 1887, p. 676) records a case of ununited fracture of about four months' duration in an infant aged eighteen months, in which he resected and wired the fragments with an excellent result. Sound union followed, and the arm, previously hardly used at all, was moved as well as the other.

In those cases where much deformity has followed union of fractured clavicle, it will be quite justifiable, with strict antiseptic precautions, to explore and remove the projecting bone, with an osteotome or saw.

I have done this in a young woman in whom a very ugly projection remained after the union of a fracture some years before. The wound healed in eight days, and not only was the deformity removed, but the pain in the hand and weakness of the limb (no doubt very largely neurotic) disappeared entirely after this operation, which was performed at the patient's urgent request.

I think such steps may well be taken more frequently. The subclavius renders the important parts below the clavicle quite safe.

PART II.

THE HEAD AND NECK.

CHAPTER I.

OPERATIONS ON THE SCALP.

BUT few—viz., those for large fibro-cellular tumours, and the vascular tumours known as aneurisms by anastomosis, &c.—will require mention in a work like this.

FIBRO-CELLULAR TUMOURS, OR MOLLUSCUM FIBROSUM.

These rare growths occasionally require removal, on account of their hideous deformity.* The chief points of importance in such operations are—I. The hæmorrhage. This may be terrific,† copious, and weeping from every part, owing to the huge size of the growth and the vascularity of the parts. It is best met by an ingenious precaution of Mr. Hutchinson's,‡ who prevented all arterial hæmorrhage during an extensive operation of this kind by applying

* A good illustration of these growths is given by Mr. Hutchinson (*Lond. Hosp. Reports*, vol. ii. frontispiece), and another by Sir J. E. Erichsen (*Surg.*, vol. ii. p. 533). The drawing in this case is said to be taken from a patient of Sir W. Stokes. This surgeon figures an excellent one (*Dub. Journ. Med. Sci.*, vol. lxi. (N.S.), frontispiece).

† It is so described by Sir W. Stokes (*loc. supra cit.*). The patient, a man aged thirty-three, in good condition, almost died on the table, Nélaton's method of inverting the head being made use of with excellent results.

‡ *Loc. supra cit.*, p. 118. The piece of scalp removed here was twice as large as the palm of the hand. Owing to the precautions taken, there was no arterial hæmorrhage. In Sir W. Stokes' case, the base of the growth was very wide, reaching from above and in front of the right ear to the left of the occipital protuberance, upwards as high as the vertex, and hanging down as low as the shoulder. In such a case, Mr. Hutchinson's plan might be made use of by applying the tourniquet carefully round the lower jaw and nape of the neck if it could not be applied from the latter point obliquely upwards on to the forehead, the strap being kept low in position, if needful, by loops of bandage passed under it on either side, and drawn downwards by assistants.

round the head, just above the ears, a Petit's tourniquet with a narrow strap. In a smaller case, strong india-rubber bands, with pads over the chief arteries, may perhaps be useful. (2) The need of maintaining strict asepsis. As nearly the whole thickness of the scalp affected must usually be sacrificed, the pericranium may be damaged and the bone necessarily exposed, especially during the tedious process of granulation by which the extensive wound must heal, unless Thiersch's grafting is used. The risk of septic ostitis and then phlebitis of the veins of the diploë is well known, with the inevitable result of pyæmia.

ANEURISM BY ANASTOMOSIS.

The treatment of these most difficult cases is given under the head of Ligature of the External Carotid.

QUESTION OF OPERATIVE INTERFERENCE IN GROWTHS OF THE CRANIAL BONES AND DURA MATER.

Under this heading are included malignant growths, usually sarcomatous, springing from the diploë or the dura mater, and having in common the features of steady progress, penetration of the skull, and pulsation. It remains to be seen what operative attacks, aided by antiseptic surgery, may avail in these cases, but for the present, unless an opportunity arise for attacking such growths quite early—*e.g.*, while they are only of the size of a small nut—it will be wiser not to interfere.*

The following case is a good instance of these growths, though it remains uncertain as to its exact origin. The question of operation, as mentioned below, was repeatedly discussed here.

D. E., aged twenty-eight, a Welsh miner, was sent to me, in 1885,† by Dr. Evans, of the Rhondda Valley. Three years ago he had noticed a swelling, the size of a pigeon's egg, in the centre of the right parietal bone; for a year previous to this he had pains in the head. During his work in the mine, his head had received repeated blows, many bluish characteristic scars being present. A month after the lump appeared, fits began to occur nightly, and lasted thus for three months; then they gradually became fewer, and for the last year there had been none at all.

* Further carefully recorded cases, with post-mortem records, paying especial attention to the possibility of removal, are much needed here. An interesting case is published by Mr. Morris (*Path. Soc. Trans.*, vol. xxxi. p. 259). The disease here certainly took six years in running its course; other deposits were present. The patient died away from London. The growth is stated to have begun in the diploë, and to have compressed, not involved, the brain. Mr. West (*Lancet*, 1876, vol. i. p. 457) records a case of fungus of the dura mater, which was explored. This case, however, from the history, appears to have been syphilitic; the growth was checked, and disappeared under the influence of very moderate pressure. Fits occurred later, and proved fatal. Deposits, thought to be scirrhus, were found in the liver.

† He was still alive in 1890.

At a spot 2 inches above the left ear was a large elevation of the scalp, measuring nearly $5\frac{1}{4}$ inches in one diameter, and about $4\frac{3}{4}$ in the other. There was no ulceration of the scalp tissues here, but unusually large vessels were to be felt over the area thus prominent. In the centre the bones of the skull appeared to be deficient over a circular spot the size of a shilling, as here the scalp could be deeply dimpled by finger-pressure as if through a ring of penetrated cranial bone. Over this central gap, pulsation was strongly marked and rather heaving; it was also present, to a less degree, over the rest of the swelling.

At other parts of the area of the growth, especially at several spots in the periphery, was a remarkable feeling as if of bony, trabecular structure. It was doubtful whether this was brought about by growth invading a flat cranial bone, or to calcification taking place in the periphery of a sarcomatous growth. On a level with the left ear was an enlarged gland.

Mr. Targett, then Surgical Registrar, reported that double optic neuritis was present, but no oculo-motor paralysis. The reflexes were normal, and there was no loss of sensation or motion.

There were no urgent symptoms; the patient had occasional throbbing and pain in the swelling, but no obstinate headache and vomiting; he was able, as yet, to work, and stipulated that no operation involving risk to life should be performed.

For these reasons, and because, owing to the size, duration, and characters of the growth, the risk of attacking it was undoubtedly great, the patient left the hospital without anything being done.

Unless such a case can be seen very early (and this is just the stage which does not come under the notice of the surgeon), the following would appear to be amongst the difficulties and risks of an operation in these cases:

The necessary difficulty and tediousness in isolating the affected bone by sufficient trephine crowns, and joining these with a saw or chisel.* In the above case at least four crowns must have been removed at the different angles of the growth. It must be remembered that the overlying soft parts were extremely vascular and perhaps (from the enlarged gland) already involved in the growth. In isolating and going wide of the affected bone, it was uncertain whether one or more sutures would not have to be crossed, and sinuses, such as the superior longitudinal, opened, thus leading to profuse hæmorrhage † in addition to that certain to be met with in dealing with the soft parts and with the diploë around the affected bone.

Then, supposing the bone sufficiently removed, wide of the growth, in one or more pieces, if the growth were from the dura mater, this membrane must certainly be dealt with, and the same would very likely be the case, if, originating in the diploë, the growth had crept inwards. In further isolating the disease, if it had merely pressed upon the brain and not involved it, most deli-

* The use of the dental engine in these cases is alluded to elsewhere (p. 174).

† An attempted removal of a growth, afterwards proved to spring from the dura mater, is recorded by Sir W. Lawrence (*Med. Times and Gaz.*, 1853, vol. ii. p. 129). The operation was abandoned owing to the hæmorrhage. The patient died about two months later.

cate work would be required: enlarged branches of the middle meningeal and, very likely, dilated sinuses would require dealing with. If the disease had involved, instead of merely displacing, the brain, new and special risks would have to be encountered just when the patient's condition, after an already prolonged operation, was least fitted to bear them.

Such are amongst the chief difficulties and dangers which appeared to me very likely, if not certain, to be met with. They do not seem to me to be exaggerated.

Moreover, in these and in any other prolonged operations which deal with the brain and its membranes, the fact must never be lost sight of that, what with the necessary interference with very vital organs, and what with the anæsthetic, the margin left to the patient between life and death may be a very narrow one.*

* About four years ago I had occasion to explore and attempt the removal of a glioma, proved later to occupy almost the entire right frontal lobe of a patient at Guy's Hospital. The pulse failed so ominously with chloroform that, after removing one crown, ether was given while the trephine was applied again, and the two openings thrown into one. The substitution of this anæsthetic was followed by so much cyanosis and jerky, gasping, irregular breathing, with a fixed chest (the patient was a young man, much emaciated by vomiting and headache, but free from any lung-trouble), that it was decided to do no more that day. The patient never "came to," and died comatose a few hours later. In this case there had not been time to interfere with the brain and its membranes. Another patient of mine, admitted for epileptic seizures connected with a huge cancellous exostosis of the frontal bone, which, as it proved, was pressing inwards upon the brain and membranes, had been under observation for a fortnight, his diet being strictly regulated. On the evening of Christmas Day, his diet having been not unnaturally, but too suddenly, altered, a severe epileptic seizure came on; this was followed by coma, rapidly deepening into death. I have elsewhere (p. 185) alluded to the suddenness with which respiration may fail in patients the subjects of middle meningeal hæmorrhage.

CHAPTER II.

TREPHINING.*

OPERATIVE INTERFERENCE† IN IMMEDIATE OR RECENT‡ FRACTURES OF THE SKULL.

Indications.—The chief of these are :

i. COMPOUND DEPRESSED FRACTURES.—Whether symptoms of compression are present or no, these fractures should, as a rule, be explored by reflecting adequate flaps, then elevating any depressed fragments, and removing any which are quite loose. At the same time the surface of the dura mater, where exposed, should be carefully scrutinised, and, together with the rest of the wound, thoroughly cleansed.

With regard to "thorough cleansing," I may draw the attention of my younger readers to the following forcible remarks of Prof. Nancrede (*loc. supra cit.*): "Suppose a recent head injury just brought into the hospital, how should we proceed? Do not carelessly pass the forefinger through the filthy, blood-matted hair and explore at once the depths of the wound to ascertain its nature, as is too commonly the rule, but carefully shave the scalp, scrub it with a nail-brush, soap and water, remove all fatty matter with

* I may take this opportunity of saying, once for all, that much of what is written below is based upon a strong belief that trephining, if carried out by careful hands, and with a strict attention to antiseptics, is, *per se*, an operation of very slight risk. This opinion was strongly put forward by Mr. Walsham in England (p. 193), and Dr. Briggs (p. 197), Prof. Nancrede, Dr. Amidon (p. 177), and Dr. J. B. Roberts (p. 170) in America. Prof. Nancrede (*Med. News*, Jan. 28, 1888). in support of the belief that trephining is not a dangerous operation, and that more die from complications which might have been prevented by timely interference than from the removal of a disc of bone, shows that the old mortality of trephining *per se*, which he puts at 10·69, is now, with antiseptic precautions, reduced to 1·6 per cent., "although it must not be overlooked that injuries to the brain, its membranes or vessels, by careless operating, will increase this death-rate."

† This term is used to include the use of the elevator and dressing-forceps as well as that of the trephine, a matter which is alluded to again below (p. 172).

‡ By these terms it is intended to make a distinction between those cases in which operative interference is made use of within a few days of a fracture, and those in which it is only had recourse to a long time after the injury : see p. 192, Trephining for Traumatic Epilepsy.

ether or turpentine and alcohol, completing the disinfection by a thorough irrigation with mercuric bichloride solution."

Operative interference is indicated in these cases for two reasons :

(a) Even if no symptoms of compression are present at first, secondary inflammation is very likely to follow in a few days, it not having been possible by expectant treatment to completely cleanse the wound. If, now, some minute fragment of the brittle inner table has pricked the dura mater, fatal septic meningitis is almost certain. If, therefore, the surgeon, in these cases, waits for evidence of compression as a justification of operative interference, he will too often wait till it is too late. Evidence of the presence of dirt,* especially of dirt ground down to, or into, the bone, is a reason for exploring the wound, even if no symptoms of compression are present. (b) If the patient recover from the immediate effects of the fracture, injury to the inner table, insufficient to cause symptoms at the time, and not detectable save by an operation, may be present all the time and cause much future trouble. In the words of Prof. Nancrede:† "Undoubtedly, many patients recover in whom the bone is not elevated, but in too many epilepsy, insanity, chronic cerebral irritation, &c., render life a burden, and operations are then required which often prove useless.‡ . . . Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation driving the dura mater against the bony fragments, Nature throws out osteophytic growths, which eventually—perhaps after years—set up serious trouble."

ii. SIMPLE DEPRESSED FRACTURES.—Where symptoms of compression are present, operative interference is the only course open. But where no such symptoms are present, the expectant treatment is by most surgeons held to be sufficient. We may perhaps come best to a decision as to using operative interference in simple

* As proving that it is not only the risk of pressure on the brain, but also the entrance of septic matter, that indicates the use of the trephine, Wagner (Volkmann's *Samml. klin. Vorträge*, pp. 271, 272)—I am indebted to Prof. Nancrede for this reference—shows that it has been proved in more than one instance that even a hair caught in a fissure will certainly produce infection if not promptly removed. The same writer puts the mortality of immediate trephining at only 1·23 ; that when twenty-four hours or more had elapsed, at 33·33 per cent.

† *International Encyclopædia of Surgery*, vol. v. p. 24.

‡ Dr. Gunn (*Trans. Amer. Surg. Assoc.*, vol. i. p. 89), speaking of later trephining for the relief of old depressed fractures, says, "Although results of these secondary operations do not show a flattering percentage of success, I think that the reason may be looked for in the late period at which the operation is performed. It is rare that the patient submits to the dreaded operation till years have been wasted in the vain endeavour to effect a cure by medication. In the meantime, the constant irritation has begotten a permanent impression upon the brain and nervous system, which remains after the offending point of irritation has been removed."

depressed fractures, without symptoms, by dividing them into the three following groups:—

1. Where the depression extends over a considerable area, where it is slight in degree—*e.g.*, not more than a sixth of an inch, especially if the patient is young and the bones yielding—expectant treatment is no doubt the best.

2. But, on the other hand, where the depression is limited and defined, where the depressed fragment not only affects a small area, but is turned down angularly or edgeways, operative interference should be resorted to at once, even though no symptoms are present, and whether there is a wound or no, to prevent the onset of dangers, immediate and remote, fully alluded to later on.

3. There is a large class of cases intermediate between the above, where the fracture is a simple one, where symptoms are absent, and where the depression is sufficient to cause anxiety, though not so sharply defined as to call imperatively for operation.

Finally, in any fracture in which the question of operative interference arises, the kind of violence must be remembered. Was this concentrated over a small area, and thus likely to bring about serious depression and comminution of the internal table, or was it indirect and diffuse, and thus likely to have produced a long fissure-fracture with little depression, but perhaps tearing open meningeal vessels or sinuses, opening up the middle ear, nose, or pharynx, and spreading far into the base?

In cases of simple depressed fracture, if the surgeon decide to wait for symptoms, he can appeal to an array of great names who concur in putting aside operative interference in these cases. While it is much to be desired that, in this as in other cases where modern surgery seems likely to reverse the weighty opinion of those who have gone on before us, no change in practice shall be made hastily, it is impossible to write on this matter nowadays without seeing that, owing to the introduction of antiseptics and the lessening dread of operations on the skull and brain, the pendulum of opinion, which has for so many years swung in the direction of non-interference, is now coming back towards the opposite view.

However these questions may be decided, it will be agreed that all surgeons departing from the time-honoured rule of non-interference in simple depressed fractures without symptoms, must, by paying careful attention to the following points, make certain of not bringing disrepute on trephining or elevation of bone:

1. That a freer use of the trephine in doubtful cases can be justified alone by keeping the wound strictly aseptic throughout.

2. Any conditions contra-indicating the operation must be carefully looked for—*viz.*, (1) Encephalitis; (2) Injury to the base.

Influence of Site.—It is often said that a depressed fracture, even if distinctly marked, over the frontal sinuses, does not require operative interference, and that any such steps should be avoided

for fear of leaving a fistulous opening leading to passage of air and troublesome emphysema. But it must be remembered that these sinuses do not appear before the age of fifteen or sixteen, and that, even in adult skulls, the extent of their development is most uncertain, the sinuses being sometimes represented by a small unilateral cell instead of fair-sized bilateral cavities.* Other sites, which it is well to avoid in trephining, if possible, are the position of large sinuses,† that of the trunk and chief branches of the middle meningeal artery,‡ and also the lines of the sutures, apart from any subjacent sinuses, as here the dura mater is firmly attached, unless it chance to be loosened by a violent blow. *Age*, too, must have proper weight attached to it, it being well known that in the first few years of life a very considerable depression may take place after an injury, and yet be followed by absence of head-symptoms and by spontaneous recovery.§

iii. PUNCTURED FRACTURES.—Here, however slight is the injury to the outer table, that inflicted upon the inner is certain to be much more serious. And the more the diploë is present, the more

* Hilton, *Guy's Hosp. Reports*, second series, vol. viii. p. 362, *Notes on the Cranium*, p. 8, *et seq.* See p. 213, a case of fatal injury to this region.

† It is worth while to bear in mind that if a large venous sinus is opened into, the hæmorrhage is usually at once arrested by *very moderate pressure applied at the right spot*. The pressure should be made by a carbolised finger or sponge, and kept up if needful by a pad of dry aseptic gauze dusted with iodoform, left *in situ* for two or three days if possible. Dr. Cameron (*Lancet*, 1884, vol. i. p. 931) was able to complete a trephining while very slight pressure with lint controlled the bleeding from a wound in the superior longitudinal sinus. He points out that the imaginary fear of fatal hæmorrhage from such a wound may at times deter from a necessary operation with the trephine, and it is well that it should be dissipated. Dr. Hopkins (*Ann. of Surg.*, vol. ii. No. 7, p. 67), in a case of extensive compound fracture of the skull, found that a small lint-compress, dusted with iodoform, lightly applied to a wound in the superior longitudinal sinus exposed by elevation of fragments, readily arrested the hæmorrhage, which persevering efforts with tenaculum-forceps had failed to check with a ligature. Dr. Parkes (*Ann. Anat. and Surg.*, vol. viii. p. 118), in treating a wound caused by a fracture of the skull, arrested the terrific hæmorrhage first by pressure, and then by introducing three fine catgut sutures. These entirely closed the rent and controlled all bleeding, and though the calibre of the sinus was reduced fully one-third, and the sinus bulged markedly at the anterior extremity of the sutured wound, showing interference with the backward blood-flow, there was no evidence of cerebral disturbance due to this interference with so large a column of blood, the wound healing well with antiseptic precautions. The strictest antiseptic precautions should be made use of in dealing with wounds of these sinuses owing to the great risk of septic phlebitis and pyæmia.

‡ The treatment of hæmorrhage from the middle meningeal artery is given at p. 186.

§ Good instances of this are given by Mr. Le Gros Clark (*Diagnosis of Visceral Lesions*, p. 94); Mr. Bryant (*Surgery*, 2nd ed. vol. ii. p. 357); Prof. Nélaton (*Pathologie Chirurgicale*, tome ii. p. 149). The two last are accompanied by illustrations.

extensive will be the damage which its fragments, when driven down, will inflict upon the brittle inner table. It must be remembered that punctured fractures, with all their serious results, may be caused by blunt, though pointed, bodies, as well as by sharp ones.* Instances of these are, blows with a pickaxe, fragments of brick-bat, coal, stone, the trigger of a clubbed gun, or falls on a fender-ornament. Immediate operative interference—and here, owing to the limited injury to the outer table, the trephine will be called for—is imperatively demanded in all punctured fractures, however insignificant is the damage to the scalp and outer table.†

iv. IN SOME CASES OF FRACTURE ABOUT THE INNER ANGLE OF THE ORBIT.—A small trephine should always be used (together with a small gouge) in exploring those grave injuries which may be caused by direct violence from thrust wounds at the inner angle of the orbit, or root of the nose—*e.g.*, with scissors, slate pencils, ferrules of walking-sticks, &c.

The apparent slightness of these injuries, the trifling wound, the period of latency of symptoms, and the onset of fatal brain mischief—inevitable, though delayed, if let alone—are all well shown in the following case of Mr. Hulke's:*

A little girl, aged six years, falling with a piece of slate-pencil in her hand, it pierced her right eyebrow near its inner end, and broke short off. Admitted soon after into the Middlesex Hospital, the house surgeon took out of the wound several splinters composing, he thought, the whole piece, covered the wound with a pad of lint, and had the child placed in bed. Her general condition did not betray the serious nature of the injury. She slept quietly through the night, and

* Prof. Nancrede (*loc. supra cit.*, p. 18) points out that a punctured fracture caused by a sharp instrument may consist of merely a splitting off of a small scale of the inner table, but that a blunt-pointed body will comminute the inner table extensively by breaking up the *deploë*.

† Hence it follows that exploratory perforation of the cranium is justifiable in all cases where the nature of the impinging force or the appearance of the external table renders spiculation of the inner table probable; provided that less danger to life and health is inherent in perforation than in the probable spiculation. . . . I am driven to the conclusion that exploratory perforation to determine the absence or presence of internal spiculation is often demanded by the uncertainty of the invisible condition. Without a knowledge of the true state of affairs, treatment is empirical; and the risk to subsequent mental health or to life is too great to permit reliance upon empirical treatment when a knowledge of the true condition is obtainable with the slight danger that pertains to antiseptic trephining. Whenever the fracture, whether originally an open one or so made by any incision, presents the possibility of the inner table being detached and splintered more extensively than the outer, I should be inclined to advise perforation. In other words, I would cut the scalp to see the condition of the outer table, and I would cut the bone, to see the condition of the inner table, in every case where the risk of obscure knowledge is greater than the risk of divided scalp and perforated bone.—Dr. Roberts, *Ann. of Surg.*, vol. ii. No. 7, p. 14.

‡ *Syst. of Surg.*, vol. i. p. 586. As here pointed out, the injury is especially likely to be overlooked if the instrument has slipped under the lid, and so reached the roof of the orbit and base of the skull, leaving, it may be, merely a patch of ecchymosis on the conjunctiva.

next morning did not appear much worse for the accident. In the afternoon, when I then first saw the child, I detected with the probe another splinter of the pencil, and enlarging the little puncture exposed a piece of pencil tightly plugging a hole in the bone. Enough of this was cut away cautiously with a gouge to allow the pencil to be grasped with a forceps. It proved to be shattered, and splinters representing a cylinder three-quarters of an inch long were removed. Intracranial inflammation (indicated by convulsions, delirium, a high temperature -103° —and rapid pulse) supervened. On the ninth day after the injury, the temperature fell to 97.5° (the child had passed a quiet night, and took her food better), and from this date it continued subnormal, or only slightly exceeded the normal average, until the sixteenth day, when it rose suddenly to 104° . With this elevation of temperature were associated restlessness, delirium, a flushed face, screaming, vomiting, convulsions, and coma. Death occurred about twenty-four hours later. At the necropsy, a large abscess was found in the frontal lobe of the right hemisphere. It enclosed a piece of pencil about 1 inch long, and it had evidently quite recently burst into the anterior horn of the lateral ventricle. It is a matter of regret that the trephine was not employed instead of cutting away the bone around the pencil, which had the effect of loosening the splinters, and contributed to the fatal mistake that the whole piece of pencil had been removed.

V. FOR THE REMOVAL OF FOREIGN BODIES FISSURING OR FRACTURING THE SKULL.—These are rare—*e.g.*, penknife-blades, pieces of stone, bullets, &c. To ensure certainty of complete removal the trephine will usually be required.

The following cases show how the gravest results may ultimately follow on the overlooking of a small piece of knife-blade. Both, the first case especially, are good instances of the long time which occasionally intervenes between the injury and the onset of urgent symptoms due to abscess.

The first case is given by M. Dupuytren.*

Il y a huit ou dix ans, un jeune homme reçut dans une querelle un coup de couteau sur le sommet de la tête ; ce couteau se rompit dans la crâne, après l'avoir perforé. Le chirurgien qui pansa le malade n'examina point avec tout le soin désirable l'état de la plaie ; il en rapprocha les bords, et le malade guérit. Plusieurs années se passèrent sans accidents ; seulement, de temps en temps, le malade ressentait des douleurs dans sa cicatrice. Au bout de quelques années, sans cause connue, il lui survint un assoupissement très-fort de la fièvre ; il vint à l'Hôtel-Dieu et y fut reçu. En examinant sa cicatrice, je sentis quelle était soulevée et dessous elle un corps étranger ; j'incisai et fis l'extraction d'une portion pointue de lance de couteau, à l'aide du trépan. Les accidents persistèrent, il s'y joignit la paralysie du côté du corps opposé à celui de la tête qui était blessé. J'incisai la dure mère, il ne sortit rien ; je plongeai un bistouri avec précautions dans le cerveau, et il jaillit de suite un flot de pus. Le soir même de cette opération, tous les accidents disparurent ; la fièvre, la somnolence et le délire ; et le malade guérit.

In the following case of Prof. Nancrede's,† the apparent slightness of the injury, the long absence of symptoms, then their sudden onset, the difficulties met with during trephining, the results of promptly meeting them, and, finally, death due to a hernia cerebri, are all deserving of careful attention.

* *Leçons Orales de Clin. Chirurg.*, second ed. vol. vi. p. 146.

† *Intern. Encycl. of Surg.*, vol. v. p. 83.

On March 6th, J. Y., aged nineteen, walked into the Episcopal Hospital, complaining of a sore on the top of his head, the result of a blow received two months previously. On examining the wound, in the centre of an ulcer, located about the position of the left middle parietal lobe, was found the broken edge of a knife-blade. On being told of this he seemed thoroughly surprised. But little could be made out as regards the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not, at that time, nor afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed, but in the afternoon of the same day he had slight pains in the head. March 7th, had slept well. No headache, temperature 100° . Slight retinal hyperæmia. March 8th, epileptiform seizures set in to-day, beginning with twitching of the right arm, but soon becoming general. Prof. Nancrede trephined over the seat of injury, the bone removed showing a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. During the next three weeks the fits apparently ceased, but symptoms indicating cerebral abscess—viz., temperature often low, $97\frac{1}{2}^{\circ}$ – 98° , slow pulse, marked mental dulness—set in. March 30th, temperature 99° , pulse 70. The patient was unconscious, with right-sided hemiplegia, and rapidly sinking. Prof. Nancrede, on reflecting the flap covering the trephine hole, found it filled by the tensely stretched dura mater, pulsating strongly. A small incision was made through this, but nothing was evacuated. The coma rapidly deepening, an aspirator needle, connected with a vacuum, was passed in at three or four different spots to the depth of $\frac{3}{4}$ inch, but with no result. Feeling convinced that pus was present, and from the symptoms that it was compressing the ascending frontal and parietal convolutions, Prof. Nancrede proceeded to set a large-crowned trephine in front of and below the first opening, which was slightly behind the fissure of Rolando. Before the skull was half divided both pulse and respiration ceased. The operation being rapidly completed, the dura mater was incised without result. At this moment a large drop of pus oozed up through one of the aspirator punctures. A knife being plunged into the brain substance, from 1 to 2 ounces of pus were evacuated. The patient appeared to be quite dead, but vigorous and prolonged artificial respiration revived him. The next day a hernia cerebri as large as a walnut was protruding from the wound in the dura mater. This increased in size, and broke down, the patient dying on April 4th. At the autopsy the left parietal lobe formed an enormous abscess cavity, the abscess being superficial, and destroying the greater portion of the upper part of the left hemisphere.

TREPHINING * IN FRACTURED SKULL

(Figs. 70 and 71).

The scalp having been shaved and thoroughly cleansed (p. 166),

* It has been already stated that in many cases of depressed fractures, after exposure of the fragments, a pair of dressing-forceps and an elevator may do all that is required. That the trephine itself is not always needed should be clearly understood, as it is probable that elevation of fragments might most wisely have often been performed if it had not been for the absence of a special instrument, wrongly supposed to have been essential, or for the dread of an operation of undoubted severity with its necessary laceration of the vascular diploë, and requiring delicacy and skill also.

the patient brought under the influence of A.C.E. or chloroform,* unless a condition of unconsciousness renders this unnecessary, the head is supported on sand-bags at a convenient height. The fracture is next exposed, the old-fashioned crucial, T- or Y-shaped incisions being now, when possible, replaced by the semilunar flap of Prof. Horsley.† The incisions should usually go down to the bone itself, and the pericranium should be raised, by the handle of the scalpel, cleanly and regularly off the bone, together with the flaps. If it be needful to operate through the temporal muscle, its fibres must be sufficiently severed and raised with the flaps, it being somewhat more difficult to separate the periosteum here, on account of its thinness in this region, and more intimate adhesion to the subjacent bones.‡ In reflecting the flaps, free hæmorrhage is nearly always met with, especially in the case of the chief superficial trunks and the deep temporal arteries, but this is promptly and easily arrested by the use of Spencer Wells's forceps, which act as most useful retractors, taking up but little room, while at the same time they arrest the hæmorrhage. If bleeding continues from any crack in the bone which may now be found, it will only cease on the elevation of the fragment, or on the exposure of, and the dealing with, any subjacent clot. The fracture being now in view, and it being found impossible to introduce an elevator or pair of dressing-forceps, even after sawing off any projecting angle of bone, the surgeon must decide where to place his trephine. In doing so, he must choose a spot, if possible, clear of a sinus (p. 169), or large branch of the middle meningeal artery (p. 185),§ and one which will at the same time support firmly the pressure needed in the working of the trephine. Thus the pin and the greater part of the trephine-crown are placed on sound bone (Fig. 70), while a small part of the trephine usually overhangs a depressed fragment. But if the surgeon fears that the fragments are in contact with the dura mater, and perhaps injuring it, and that the jarring movement of the trephine coming in contact with one may be pernicious, he will so place his

* I much prefer these anæsthetics, if possible, in cases of trephining, on account of the greater excitement and congestion which are usually associated with ether. But whenever it is possible, and especially when the pulse and breathing are falling, anæsthetics should be dispensed with (p. 165). Where there is any tendency to drowsiness or coma "the anæsthetist should attempt to secure an analgesic rather than a true anæsthetic state" (Hewitt, *Anæsthetics and their Administration*, p. 54).

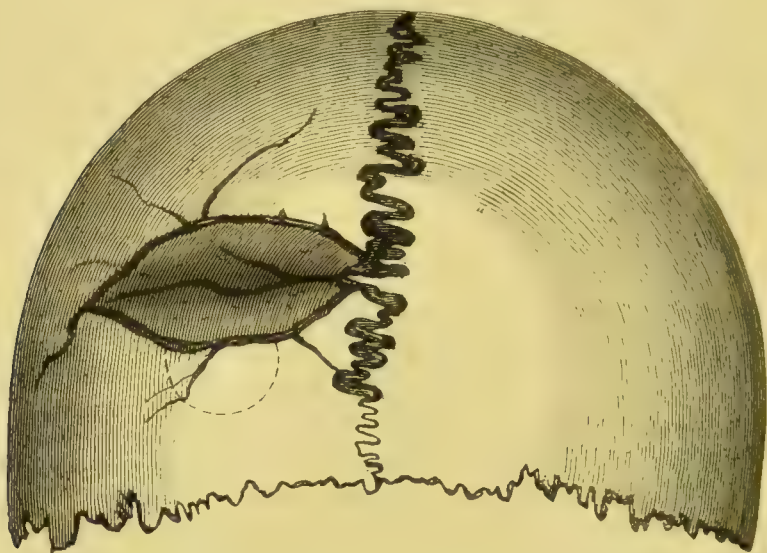
† See below, p. 244. The flap has these advantages:—(1) Readily detached, it easily carries the periosteum with it. (2) It exposes the bone freely. (3) It allows of more thorough use of antiseptics. (4) It prevents the occurrence of a hernia cerebri.

‡ The greater thickness of the soft parts which will here form the cicatrix will, in a measure, make up for the difficulty in preserving the periosteum.

§ If it is really needful to trephine over one of these vessels, the remarks at pp. 169, 186, will show how the hæmorrhage should be met.

trephine that it rests entirely on sound bone, any intervening bridge being easily cut away (Fig. 71). A spot being thus chosen, a trephine of appropriate size is taken,* with the centre-pin protruded for about a tenth of an inch, and firmly fixed in this position, the trephine being so grasped in the hand, that the index finger steadies the centre-pin screw when the bone is entered. The instrument is now firmly applied to the bone, the centre-pin being bored inwards, and as soon as the teeth feel the bone, the trephine is worked from left to right and then from

FIG. 70.



Compound depressed fracture of gutter form. There being no comminution, the trephine has been placed close to, and, in part, overhangs the fracture. (Hutchinson.)

right to left, care being taken to exert equal pressure in both directions; while the first groove is being cut, the movements of the trephine must be light and quick, but without jerking, the tendency of the instrument to slip being met by steady bearing on the centre-pin, and by keeping the left forefinger at first on the bone, close to the trephine.

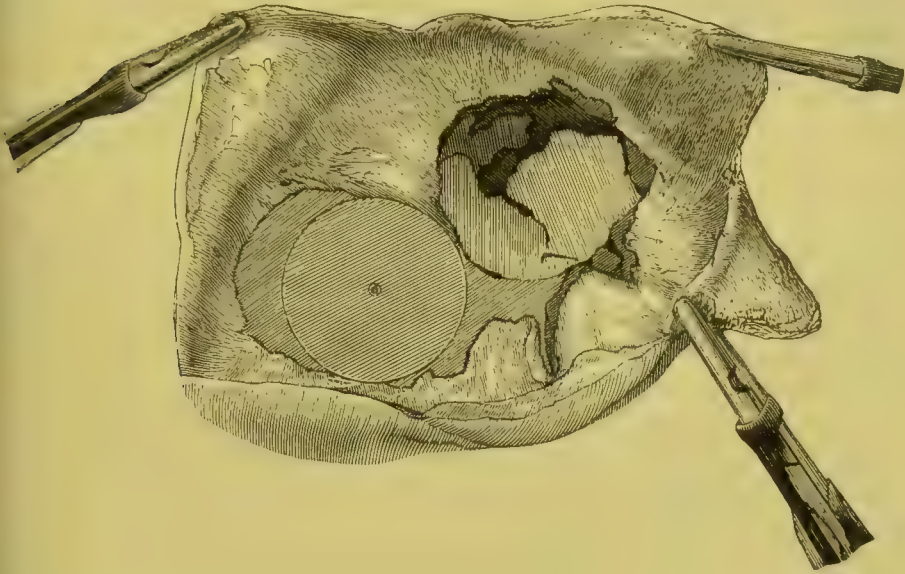
As soon as a groove has been cut sufficient to keep the trephine steady, the pin is drawn upwards, and so fixed. The rotatory

* One $\frac{3}{4}$ inch in diameter is usually ample. The conical trephine is said by American surgeons (e.g., Nancrede, *loc. supra cit.*, p. 96; Dr. Hopkins, *Ann. of Surg.*, vol. ii., No. 7, p. 69) to be safer than the ordinary one, it being almost impossible, owing to its greater steadiness, to injure the brain with it, if, as the deeper part of the internal table is divided, any undue pressure should be made. But if used with ordinary skill, the old form of trephine is perfectly safe. The modified burr of the dental engine has been found to work accurately by some American surgeons—e.g., Dr. Roberts (*loc. supra cit.*), especially in removing large areas of bone. Hitherto, simpler, old-fashioned instruments have held their place in England.

movements alternating from side to side are now continued, care being taken to bear as evenly as possible on every part of the circle, till the diploë* (if this be present) is reached. This is known by the easier working of the instrument, and by the softer sound. On the living body at least, owing to the oozing from the vascular parts around, the blood-staining of the bone-dust described as taking place at this stage is liable to be fallacious.

Throughout the operation, but especially now as the thinner table is being reached, every care must be taken to keep the circle of equal depth—(1) by pressing on the saw evenly; (2) by making

FIG. 71.



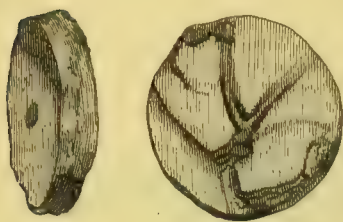
Severe compound fracture of skull. The bone being much damaged by comminution, the trephine has been placed at a little distance from the fracture, so as to be on sound skull. The intervening bone would be readily clipped away with bone-forceps. The flaps are retracted, and cut vessels in them at the same time commanded by three pairs of torsion-forceps.

it bite in as equally from right to left as from left to right; (3) by remembering that, owing to the skull being spheroidal in shape, it is impossible, without the greatest carefulness, to keep the groove of equal depth all round; (4) by bearing in mind that while the average thickness of the adult skull is one-fifth of an inch, the thickness varies so much that it is almost always greater

* This is absent in early life and in the aged. Again, over a large part of the squamous bone and in the occipital fossæ, diploë is never met with. Thus, in cases where the diploë is absent, especially in the thinned calvaria of an aged corpse, it is quite possible, by using haste or force, to jam the crown of bone in upon the brain.

at one part of a trephine-circle than at another* (Fig. 72). Thus at frequent intervals the flat end of a trephine-probe, or a clean quill cut pointed, must be carefully introduced at different spots, and when the circle is found to be deeper on one side (still more if it is perforated) the trephine must be so slanted that its teeth are only cutting on that part of the groove which is still shallow. When the groove has been made sufficiently deep, and careful examination finds three or four points of penetration, the bone

FIG. 72.



may be removed by inserting the elevator at the deepest part of the groove and lifting up the disc of bone by carefully making a fulcrum of the sound bone or of a finger.

If profuse hæmorrhage occur on raising either the disc of bone or a depressed fragment, it will probably come either from a branch of the middle meningeal artery or from a sinus. The treatment of the former is given at p. 186; in the latter case pressure should be at once applied by means of a piece of sponge which has been kept in and wrung out of a solution of carbolic acid, or mercury perchloride, and dusted with iodoform powder; if this has to be tucked under an edge of bone to control the bleeding, a ligature of carbolised silk should be fastened on to it, to secure its withdrawal in about three days' time (p. 169).

In the case of a punctured fracture, a full-sized inch trephine should be applied, so as to remove the outer table around the immediate neighbourhood of the puncture, and thus expose freely the damage to the inner table.

If after removing a crown of bone more room is still required, this may be obtained either by taking out a second crown close by and joining the two, or by the use of a Hey's saw or Hoffmann's forceps; with the latter instrument, if of reliable temper, a considerable area of bone can be quickly nibbled away.

Mr. West recommends that the periosteum, which has been carefully preserved, should be adjusted with catgut sutures, this precaution tending to prevent any subsequent hernia cerebri. Sufficient drainage must of course be provided.

With the same view, in order to diminish the subsequent gap, any detached fragments of bone (which should have been kept in hot (T. 105°) bichloride solution, 1 in 3000), may be placed across

* Mr. Holden's words (*Landmarks*, p. 5) are excellent:—"Think that you are operating on the thinnest skull ever seen, and thinner in one half of the circle than the other." Sir A. Cooper (*Surgery*, vol. i. p. 188) thus speaks of the operation:—"Some people say that this is a trifling operation, not difficult to perform, nor dangerous; but they deceive you: it is one of the most dangerous operations in surgery; whilst performing it there is but a single step—a small network—between your patient and eternity."

the aperture in the skull, it having been found by Prof. Macewen* that they will adhere and give no further trouble. Any bone thus used must be rendered absolutely aseptic. If any fragments are too large, they may be cut up with a sharp bone-forceps or chisel. Sufficient drainage is then provided by fine tubes or drains of horsehair (a drainage-tube being generally used where the dura mater has been opened, where the brain has been damaged, and in all cases of cerebral abscess), sutures inserted, and dressings applied.

The terse summing up of Dr. Amidon (*Ann. of Surg.*, No. 3, vol. i.) may here be quoted: "Let the operation always be done with antiseptic precautions. Try and secure only proximate coaptation of the flaps. Provide the freest possible drainage. Use cold † antiseptic dressings without much compression. Enjoin the strictest quiet in a posture facilitating drainage."

TREPHINING FOR PUS BETWEEN THE SKULL AND DURA MATER.

While the mode of using the trephine here will in no way differ from that already given, a few practical remarks will be made on this most important condition.

It is well known that operative interference here is now less frequent than it would appear to have been a hundred years ago

* *Ann. of Surg.*, Oct. and Nov. 1887. On this subject I would refer my readers to Prof. Macewen's case (p. 103). Prof. Keen, of Pennsylvania (*loc. infra cit.*), in one case replaced the button of bone on the under surface of the flap, and secured it there with chromic gut ligatures passed through two openings made in the bone and then through the scalp. The bone was thus prevented from falling upon the brain, and its adhesion to the scalp secured. About five weeks later the bone was firmly adherent to the scalp, but not to the sides of the opening, as it could be moved by pressure. Mr. Clark (*Lancet*, 1886, vol. i. p. 243), in a case of trephining for traumatic epilepsy, in which this operation was followed by much improvement, but not a complete cure, replaced the crown of bone—a piece of the frontal, and the seat of osteitis—after bevelling off the inner edge so as to prevent pressure upon the dura mater, and after cutting a notch in the side of it to serve for drainage. The restored crown did not necrose, but united satisfactorily. However right it may be to replace, in most cases, bone which has been removed, especially in those cases where the removal has been extensive, I doubt very much if this course is judicious in cases of trephining for traumatic epilepsy. Until this subject has been more thoroughly worked out, I think it would be wiser to leave the small trephine-gap not filled up, and thus provide a safety-valve for the relief of varying tension. This course would be especially indicated in cases of long-standing depressed fracture where trephining is resorted to late, and though the source of irritation is thus removed, the brain has taken an impression, which, though perhaps latent, will remain permanent and which will be prone to show itself on very slight excitement. See footnote ‡, p. 167.

† Boracic acid lint and iodoform, the dressing kept moist with iced boracic acid, is soothing, and gives excellent results when the patient is not restless.

when Mr. Pott drew the attention of surgeons to the need of trephining when pus was present immediately beneath the skull. For while Mr. Pott, in his day, saved five out of eight of these cases in which he trephined, surgeons of the present time, when they trephine, have been usually baffled by the co-existence of pyæmia, or, if this ominous complication be absent, by finding the collection of pus not localised between the bone and dura mater, or, if so localised, combined with suppurative arachnitis also.

Mr. Holmes (*Treat. on Surg.*, first ed. p. 130) brings forward the following weighty statements: "Some years ago I published (*Brit. Med. Jour.*, Oct. 16, 1858), the experience of St. George's Hospital in this particular for seventeen years—1841 to 1857 inclusive. Eight cases occurred in which the trephine was applied for pus. The pus was found in every case, but all the patients died. Seven were examined after death, and in six of these unmistakable evidence of phlebitis in the sinuses of the brain and veins of the skull and of general pyæmia was discovered. In the seventh case the abscess reached the ventricles of the brain. There were eight other cases in which the trephine was not used, and where matter was found above the dura mater, but it was not limited to this situation in any of these cases, nor would adequate exit have been procured for it by the trephine. In nine other cases there had been intra-cranial suppuration, but the matter was diffused among the membranes or in the substance of the brain, and lay entirely below the dura mater."

The above most gloomy picture of what has been usually met with only serves, I think, to confirm the opinion given below (p. 179), that these cases should be explored early, being treated, in short, more like cases of acute periostitis and osteo-myelitis elsewhere than has hitherto been the case.

When it is remembered that pus does not form between the bone and dura mater without a previous stage of traumatic ostitis and phlebitis of the veins of the diploë, it will be readily understood how easily, if the wound be foul, septic osteo-myelitis and septic phlebitis, with the inevitable result of pyæmia, will follow.

Indications of the Formation of Pus between the Bone and Dura Mater; Question of Trephining.—History of a head injury with damage of some kind to the outer table. Thus there is often a scalp wound exposing the pericranium, often opening this up at one or two points, perhaps small and not seen at the time; occasionally the bone itself is laid bare by the injury. Either now or later on the wound becomes septic. After a varying period, usually in the course of the second week after the injury (during which period definite symptoms are often absent), headache, fretfulness, nausea, or vomiting sets in, gradually followed by drowsiness, delirium, twitchings, convulsions, paralysis, coma, and death.

This on-rush of symptoms about the eighth or tenth day may be accompanied by evidence of pyæmia—viz., rigors followed by sweating, a jactitating temperature, progressive emaciation, and

affections of viscera and joints, amongst which pleuro-pneumonia is one of the most frequent and grave.

The surgeon who is watching a case of this kind, and also is not unmindful of what has happened and what is liable to be going on—the injury to the pericranium and bone, the otitis and osteo-myelitis with plugging of the diploic veins, the extension to the inner table, the formation between the bone and dura mater of lymph ready to suppurate, this deep-seated inflammation being only too ready to extend to the arachnoid and thus become a diffused meningitis—will find it a matter of much difficulty to answer the question, How far has the mischief gone? Is the case a hopeless one? If the intra-cranial collection of pus be a localised one and uncomplicated, well-marked hemiplegia and the absence of pyæmic symptoms will call hopefully for trephining. On the other hand, paralysis, indistinct or complete, epileptiform convulsions, extreme irritability, and, especially, any evidence of involvement of nerves at the base, will all point to that form of meningitis which will show itself as a diffuse layer of pus and lymph over one side of the arachnoid.

Equally pointing to a fatal issue will be the symptoms of pyæmia already alluded to, and needing no further mention here.

What is to be done in these cases? Where the evidence of meningitis is undoubted, of some days' standing, where the hemiplegia has been little marked, or where it is replaced by paraplegia, general convulsions, and other unfavourable signs, no surgeon will be wise in trephining.

Should evidence of co-existing pyæmia be looked upon as equally hopeless and equally negating the use of the trephine? I scarcely think so. Every surgeon knows that, although pyæmia is usually fatal, it, very occasionally, ends favourably. Again, in treating pyæmia resulting from periostitis and osteo-myelitis elsewhere, we are not deterred from making free incisions and exploring the bone.

The right treatment of these cases must, of course, be really preventive—*i.e.*, every scalp wound should be rendered aseptic and kept so from the very first, however slight it seems to be. But, as this precaution is not always taken, and is occasionally impossible, the condition of the pericranium and bone should be explored earlier, at the very first warning of danger. Instead of treating such a case as a special result of head injury, and waiting for evidence of pus between the bone and dura mater, we should, I think, deal with it as we do with periostitis and otitis elsewhere; that is to say, that, in cases of this kind where there is reason to believe that the bone has been injured, especially if there is any doubt as to the condition of the wound throughout, the surgeon should, on the first appearance of malaise, irritability, headache, nausea, chilliness, explore the wound. Any granulations here present will very likely be at a standstill. A piece of bone will probably be bare and perhaps soft, the pericranium infiltrated

and separating. The whole area of bone which is thus being deprived of its pericranium should be explored, and drainage provided. But in nearly all cases, especially if the bone is softened at all, it will be wiser to do more, and open the bone with a trephine to give vent to any inflammatory material in the diploë, to prevent septic phlebitis and its extension to the sinuses, and to save the inflammation from reaching the inner table and dura mater.

The above depends on the fixed conviction that trephining, in careful hands, and with due precautions, is not, in itself, a dangerous operation (p. 166), and on the fact, which is beyond dispute, that, if these cases are left till hemiplegia pronounces the existence of intra-cranial pus, they will, too often, be left too long, as this waiting will give time for the onset of pyæmic infection, and for the arachnoid to be involved in the inflammation.

The operation of trephining here will in no way differ from that already described. Pus welling up from the diploic cancelli, or a fetid condition of these, is ominously suggestive of impending pyæmia. If such a condition be present, the bone should be freely removed, and disinfected as far as possible; but, from the probable extension of thrombi to the sinuses, the outlook is a very dark one. If pus be present between the bone and dura mater, it must be thoroughly evacuated, and free drainage provided.* The condition of the dura mater should always be examined into, whether pus is found superficial to it or no. If it pulsate freely and be natural in appearance and devoid of lymph, nothing more need be done. If, on the other hand, it bulge into the trephine-hole devoid of pulsation, it should be punctured, this perhaps giving vent to a jet of purulent fluid from the arachnoid cavity. If the arachnoid is seen to be covered with lymph, this is of the gravest omen. The possibility of the existence of cerebral abscess must always be remembered in these cases, where nothing else has been found to account for the head symptoms. The symptoms and treatment are fully given at p. 188.

The following cases are good examples of this most dangerous condition of otitis of the cranium and its sequelæ and complications:

The first case, reported by Mr. Hutchinson (*Clin. Surg.*, vol. i. p. 97), shows pyæmia prominent rather than arachnitis; the second (*loc. supra cit.*, p. 102), also Mr. Hutchinson's, shows the reverse condition—much arachnitis and no general pyæmic infection. The third, one under my own care, shows both arachnitis and pyæmia combined. In all pus was present between the bone and dura mater.

* In these cases, and, in fact, in any trephining cases where the discharges are foul and the scalp the seat of cellulitis or erysipelas, iced boracic acid (a saturated solution) lotion applied by means of lint frequently wetted and renewed together with a dusting of iodoform, is preferable to dry dressings changed less frequently.

J. W., aged ten, on October 15 received a large lacerated scalp wound, a triangular flap of all the tissues of the scalp being torn up from the left parietal bone. The pericranium was not torn up, excepting perhaps at a few points. The boy was admitted into the London Hospital at once, the flap of scalp adjusted, and for some time all went on perfectly well, the boy being only kept in bed for a day or two. Oct. 29.—While up and at dinner he was noticed to be cold and shivery. A very severe rigor followed. It was impossible to ascertain whether he had had headache for some days or not. In the wound the granulations were pale and glassy, and a small piece of dry, bare bone was exposed. During the next few days there were repeated rigors. Nov. 1.—He had now very decidedly the aspect of pneumonia, and the breathing, temperature, pulse, and cough confirmed this. Nov. 2.—He seemed better than yesterday, the respiration being more easy. There is not the slightest sign of paralytic weakness. Doubts have been expressed as to whether this boy is or is not the subject of pyæmia. He looks comfortable, excepting for the blueness of the lips, which is less than yesterday. That he is suffering from pneumonia all must admit, and that the pneumonia does not produce the usual train of symptoms (no rust-coloured sputum, no great dyspnœa, &c.). If there had been but a single rigor, it is very possible that it might have been indicative only of pneumonia, but their recurrence seems to me to denote pyæmia. This diagnosis is also favoured by the fact of his apparent improvement at times and great variations in condition. The wound was now secreting a very fair quantity of healthy pus. Its granulations are much better than they were, and fairly florid. During the next three days the thoracic symptoms increased. He emaciated rapidly. Consciousness was perfect to the last, and he had neither paralysis nor convulsions. All traces of granulation disappeared from the wound. He died November 7. There were very numerous pyæmic deposits in the lungs, liver, and spleen. Beneath the scalp wound was bare and greenish bone the size of a crown-piece. The edges of the wound and the pericranium were loose over a surface as large as the palm of the hand, comprising, in fact, nearly all the parietal bone. There was a recent scar in the scalp, crossing the vertex transversely, just above the lambdoid suture; the pericranium here was thickened and inflamed, and the bone on both sides of the sagittal suture here was green. On applying the trephine at this spot, dirty-green, fetid pus exuded on the inner surface of the bone. It must be observed that this portion of inflamed bone extended on each side of the sagittal suture, and that it was under, not an open wound, but a soundly healed one.

E. S., aged ten, was admitted, July 21, into the London Hospital with very extensive laceration of the scalp on the left side, laying bare the parietal bone. During the first few days he seemed to be doing well. July 26.—Bone as large as a crown-piece is exposed, white and dry, above the left ear. July 29.—A strong rigor. July 30.—Wound without granulations, looking glazed. July 31.—Very restless. Uses all his limbs at times, but the left ones much better than the right. Aug. 1.—The skull was trephined in the middle of the exposed bone 2 inches directly above the left ear. The dura mater was covered with yellow lymph. It pulsated pretty freely. On cutting through it about a drachm of thin, purulent fluid jetted out. The visceral arachnoid was seen to be covered with lymph. Aug. 2.—He still uses his left arm, but never his right hand. When the brain, which bulged, pulsating, into the wound, was pressed back, thin pus ran out in considerable quantity from the arachnoid cavity. His aspect was that of a patient in the very last stage of fever. Death took place on August 3. The bone around the trephine-aperture was dry and green. Everywhere on the left side the parietal arachnoid was concealed by a thick deposit of puro-lymph, whilst everywhere on the right side the membranes were perfectly free from deposit, polished and glistening. The superior longitudinal sinus contained puriform fluid. The skull at the seat of injury was discoloured over an extent

almost as large as the palm of the hand; adjacent to it were other patches, greenish-yellow, opaque, and non-vascular. There were no pyæmic deposits in the lungs or in the viscera of the abdomen.

E. S., aged forty, slipped while getting off an omnibus, January 22, 1877, and was admitted into Guy's Hospital under Mr. Howse's care with a scalp wound 4 inches long exposing the right parietal bone. Owing to some oversight the wound was not dressed at first antiseptically,* the discharge became offensive, and erysipelas of the scalp setting in, she was transferred to my care on February 1. At this time almost the entire right parietal bone was exposed, owing to sloughing of the pericranium. Incisions were made where needful, drainage-tubes introduced, and in a few days the erysipelas had subsided, and the wound was sweet. Feb. 11.—She had a rigor for the first time. Feb. 13.—There was some paralysis of the left side of the face and the left limbs. The temperature was 104°. Feb. 15.—The hemiplegia becoming more marked, I trephined through the exposed bone, about 1 inch above the right parietal eminence. Pus was met with in the diploic cancelli. On removing the crown of bone, an ounce of thick, foul, greenish pus welled up. The inner surface of the bone was very rough, the dura mater which corresponded to it being covered with velvety granulations. As the dura mater did not pulsate, it was punctured, but without result. The patient became more conscious after the operation, but soon lapsed again into a semi-comatose state. Convulsive seizures of all the limbs, with twitchings of both sides of the face, then set in, and continued till the patient's death, on February 17. The parietal bone was found to be dying for a considerable area, the diploë being green and offensive. The pus seemed all removed from the dura mater, but there was suppurative arachnitis over the right hemisphere, reaching up to the falx in one direction and the base in the other, but stopping short of each. There were numerous pyæmic abscesses in the lungs and liver.

TREPHINING FOR MIDDLE MENINGEAL HÆMORRHAGE† (Fig. 73).

Indications.—When a patient, after receiving an injury to the head, has shown several of the symptoms given below.

It is noteworthy that the injury and amount of violence vary extremely. While most frequently serious, as in falls on the head, the violence may be extremely slight, as when a patient slips going downstairs and strikes the head against the wall, when a boy receives a blow from a cricket-ball, or when a child has a fall of 2 feet 6 inches out of a swing. From this the following conclusions follow naturally:—(a) That in the cases of severer violence, laceration or contusion of the brain are, only too frequently, complications; (b) where the violence has been slighter, either no fracture may be present, or, if one be present, it is often only a mere fissure, and may involve the internal table only.

i. *Interval of Consciousness or Lucidity.*—This interval between the stunning effects of the injury or concussion and the onset of compression from the effused blood varies, when present, in length from a few minutes to several hours. In about half the cases it is

* A precaution on which my colleague habitually insists.

† For fuller information on this most important subject, I may, perhaps, refer the reader to an article contributed to the *Guy's Hosp. Reports*, 1886, p. 147.

well marked. In a second class it is but little marked, and may easily be overlooked altogether. In a third and last set of cases this interval is never present at all, owing to (1) The presence of a very large hæmorrhage, producing compression-symptoms; (2) Co-existing depression of bone; (3) Co-existing injury to the brain; (4) Drunkenness of the patient.

ii. *Condition of the Limbs as to Hemiplegia, Paralysis, Rigidity, &c.*—Hemiplegia, though well marked in a large proportion of cases, must not be looked upon as essential, and middle meningeal hæmorrhage must not be overlooked because hemiplegia is absent, ill-marked, or replaced by some other condition of the limbs. At least, the following seven conditions of the limbs may be met with in middle meningeal hæmorrhage.

(a) Hemiplegia present and well marked, the leg or arm, and usually both, when taken up and let go, dropping like those of a corpse. This condition is present in probably one-third of the cases. It is noteworthy that occasionally the hemiplegia is on the same side as that injured, the extravasation taking place on the side opposite to that struck.

(β) Hemiplegia present, but little marked. In these cases, which are not uncommon, the extravasation may be overlooked. They fall into at least two divisions. In one the hemiplegia is little marked throughout, owing, perhaps, to some power of accommodation on the part of the brain, or to the circulation remaining feeble, owing to co-existing shock from the time of the injury to the moment of death.

In another group of cases the hemiplegia is ill marked because of brief duration, coming on as it does in these cases towards the close, together with coma, giving but little warning and leaving but short time for interference.

When there is any doubt as to the existence or degree of hemiplegia, the following tests should be carefully made use of: whether the patient resists on the surgeon attempting to move the limbs; the power of the grasp, if any; the result of pricking; whether the patient moves either of his hands, or which of them, when the cornea is carefully touched, or the cilia gently pulled.

(γ) Hemiplegia present, but temporary. A very rare condition, produced probably by the brain being able to accommodate itself to the blood.

(δ) Monoplegia, or the paralysis more marked in one limb than the other. A rare condition, as the hæmorrhage generally makes pressure upon all the motor area.

(ε) General paralysis. Another rare condition, the existence of which may be explained by a very large clot—*e.g.*, on the left side, rapidly effused and making pressure through the left side of the brain, upon the right as well, or by co-existing extravasation into the brain substance itself.

(ζ) Absence of any paralysis. A very rare condition, and one which is, perhaps, due to the blood effused from the middle menin-

geal artery, finding its way through a fracture in the skull, beneath the scalp. (See foot-note, p. 185.)

(n) Limbs rigid, convulsed, or twitching. It is only too probable here that, in addition to middle meningeal extravasation, contusion, or laceration of the brain substance will be found at more spots than one.

iii. *Condition of the Pupils.*—Whilst this may be various, there are at least three conditions which are most important.

(a) If the pupils are natural as regards reaction to light, the compression of the brain is probably recoverable if trephining is immediately performed. Furthermore, it is probably a case of compression only of the brain, without other injury.

(β) If the pupils are insensitive, often at the same time dilated, the compression is probably extreme, and while trephining is urgently called for, it is less probable that in these cases the brain will recover itself after removal of the clot.

(γ) If one pupil is found widely dilated, the other being natural or contracted in size, and if the dilatation be present on the side of the artery injured, in other words, opposite to the side of the body which is paralysed, it is a most valuable sign, the explanation of which we owe to Mr. Hutchinson (*Lond. Hosp. Reports*, 1867, vol. iv. p. 29).

Taken with other evidence of middle meningeal extravasation, this condition of the pupil points to a large clot, reaching down into the base and pressing forwards upon the sphenoidal fissure, and thus compressing the third nerve.

iv. *The Pulse.*—This will vary according as the case is one of well-marked, uncomplicated extravasation, or complicated with contusion or laceration of the brain; and, if the concussion stage has been severe, according to the degree to which the heart has recovered from this.

In well-marked uncomplicated compression, the pulse will be slower than normal—*e.g.*, 66, 52, and still falling, 42, and usually somewhat full and labouring.

v. *Coma, or Unconsciousness.*—With regard to this, the following points should be borne in mind:

(a) The degree of unconsciousness will vary with the size of the branch injured, and the rapidity with which the blood is effused. Where the effusion is rapid and the compression great, the coma may be as deep and complete as in apoplexy. But, in other cases, it will be found that though the coma is apparently deep, this is not really so; thus the patient may moan constantly, or may move his limbs feebly when disturbed.

(β) The commencing coma may be taken for natural sleep, or drunkenness, in which conditions the patient may be allowed to lie till it is too late.

(γ) In a few cases, the onset of the coma is deferred till late; its onset is here sudden, its course rapid, and it generally ends in death.

vi. *Respiration*.—This, in well-marked cases, is often stertorous and somewhat slow. In cases where stertor has not supervened to call attention to the existence of compression, other and still graver alterations in the breathing may be present, alterations which are warnings that the end is not far off, and that, in the case of intended trephining, there is no time to lose—viz., catchy, short respirations, cyanosis, and gasping, irregular breathing, ceasing for intervals of ten or fifteen seconds, and then repeated.

vii. *State of Scalp*.—When the history is deficient, or when the signs of compression are not well marked, ecchymosis or contusion of the parietal and temporal regions giving rise to a pulpy or puffy feel are of great value. This condition will be especially marked, when the hæmorrhage from the middle meningeal artery is finding its way through some fracture into the tissues of the scalp.*

Treatment.—Early trephining should be performed as follows:—The scalp should be shaved widely, for the liberal application of ice, later on, if needful. No anæsthetic should be given if the patient is unconscious, or the respiration failing. The head being supported on sand-bags or a firm pillow, the middle meningeal area on the side which is bruised, and on the side opposite to the hemiplegia, is explored by turning up a semilunar flap, the centre of which is $1\frac{1}{2}$ inch behind the external angular process, and 1 inch above the zygoma, or Kronlein's point of election in doubtful cases may be made use of. This is from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch behind the external angular process, on a line drawn backwards from the upper margin of the orbit. This will expose a diffuse, a temporo-parietal and a fronto-temporal hæmatoma. If the first perforation prove fruitless, a parieto-occipital hæmatoma is to be sought for by a second perforation made over the posterior branches of the artery. The best point for this is on the line above given, prolonged backwards, at its intersection with a vertical one carried up directly behind the mastoid process (*Deutsch. Zeitschr. f. Chir.* Bd. xxiii. Hft. 3 u. 4, March 1886). The brisk hæmorrhage which takes place from the scalp will be best arrested by applying Spencer Wells' forceps to the bleeding points, the forceps thus not only arresting hæmorrhage, but acting as retractors also (Fig. 71). The pericranium is then carefully separated, and any fissure or fracture looked for on the bone. Whether one is found or no, a crown of bone is next removed with a full-sized trephine. When this has exposed the clot,† hæmorrhage may still be going on,

* There is a good specimen of this in St. George's Hospital Museum, Series No. 4, figured by Mr. Holmes in his *Surgery*, 4th ed. p. 140, Fig. 39. It shows the parietal bone of a child, in which a gaping fissure crosses the middle meningeal artery, producing considerable extravasation inside the skull, and still more externally. I have lately trephined successfully in a similar case. Here, during the half-hour which elapsed between the time of admission and operation, a distinctly increasing swelling was noticed in the scalp of the child.

† Perhaps another crown must be removed for this. Thus, in one case, when

warning of which will, perhaps, be given by the pulsation of the clot. This being removed by a small lithotomy scoop, one of Volkmann's spoons, or the handle of a small teaspoon, the hæmorrhage may cease, or it may continue profusely, welling up from a point quite out of reach. In such cases, the surgeon may, after saving his patient from the dangers of compression, have to face those of most serious hæmorrhage. In such a contingency, the

FIG. 73.



Middle meningeal hæmorrhage with extensive fracture of the skull. Prep. 1593⁶¹, Guy's Hospital Museum. From the severity of the fracture which involves both vault and base such a case gives very little hope.

following steps may be made use of: (1) Crushing together with forceps the edge of the bone from which the bleeding comes; (2) If the bleeding spot is found by the aid of a pointed probe to lie in a distinct bony canal, the hæmorrhage may, perhaps, be arrested by plugging this canal with a tiny, aseptic wooden peg;* (3) The use of cold, either in the shape of large ice-bags over the side of the face, head, and neck (M. Beck), or, as a freezing mixture, three parts of salt and two of ice (Howse); (4) Pressure, by suturing the

trephining over the trunk of the middle meningeal, I came down on the prolonged tail-like extremity of a huge clot, reaching far away upwards and backwards, and due to a branch being opened at some distance by a most extensive fissure.

* This was suggested by Mr. T. Smith, and used successfully by Mr. Willett and Mr. H. Marsh, at St. Bartholomew's Hospital, in cases of hæmorrhage from descending palatine artery (*Clin. Soc. Trans.*, vol. xi. p. 71).

edges of the wound,* first firmly plugged with strips of iodoform gauze wrung out of 1 in 20 carbolic acid lotion, or by digital pressure on the common carotid; (5) The above means failing, which is unlikely, ligature of the common or external carotid had better be resorted to.† If such a step be really needful, a temporary closure of the common carotid (see ligature of this vessel) will perhaps suffice.

Whether the surgeon should remain satisfied with a single trephining and partial removal of the clot, or, having exposed the clot, proceed to remove the skull, and then the blood, more extensively, must depend chiefly on the state of the patient, the size of the clot, and whether the depression in the dura mater begins quickly to pulsate and to rise up. If these last points are in doubt, there should be no hesitation, the condition of the patient admitting of it, in removing more crowns of bone, these being kept in a hot aseptic solution (p. 176).

Prognosis.—With reference to this point, I may quote the following remarks from my paper in the *Guy's Hospital Reports*, vol. xliii. :

“The chief points on which this depends are, whether the middle meningeal extravasation is probably complicated with such injuries as extensive fractures and brain injury, and secondly upon the date of trephining, and whether, at this time, the brain recovers itself quickly or not. With regard to the former, or the existence of complications, the surgeon will, if asked to state the probable result, base his opinion on the history of the case, the severity of the violence, *e.g.*, height of fall, whether any interval of lucidity has been present, and, if so, for how long and how far this has been well-marked, how far the symptoms of compression, well-defined hemiplegia, the falling pulse, the stertorous breathing, &c., are present or replaced by, or complicated with, those symptoms which are believed to point rather to laceration or contusion of the brain and its membranes—viz., restlessness, convulsive movements or twitchings, pulse quick and sharp, and other evidence of pyrexia, which show that inflammation of the brain has probably supervened upon the injury to its substance.”

The seventy cases on which the above paper was based appeared to fall into the three following groups :

* This can only be carried out when the edges of the wound are clean cut, and also when the surgeon is able to see his patient at short intervals, or to leave him in competent hands; otherwise, if the hæmorrhage persist, this precaution may increase the risk of that compression which the operation had been intended to obviate.

† Ligature of the common carotid, if preferred, is justified by a successful case recorded by Dr. Liddell (*Amer. Journ. Med. Sci.*, vol. lxxxi. p. 344), in which secondary hæmorrhage from the middle meningeal artery, three weeks after a shell wound in the temporal region, was successfully arrested by ligature of the common carotid. The additional special risks of this operation are, however, well known.

A. *The Most Hopeful Cases for Trephining.*—Violence comparatively slight; laceration of middle meningeal artery or its branches; fracture of skull, if present, slight and localised to side of skull, *i.e.*, not implicating the base; compression, but little or no contusion or laceration, of brain. 27 cases.

B. *Less Hopeful Cases.*—Violence grater; laceration of middle meningeal or its branches; fracture implicating middle fossa; some injury to brain, but this only trivial. 20 cases.

C. *Cases probably Hopeless from the First.*—Violence very great; laceration of middle meningeal or its branches; fracture of skull extensive, perhaps implicating several bones and sutures both in the vault and base; injury to brain very severe. 23 cases.

Sub-dural Hæmorrhage.—Where compression of the brain by blood is suspected and none is found superficial to the dura mater, this must be always opened. The following case of Mr. H. W. Allingham's (*Clin. Soc. Trans.*, vol. xxii. p. 220; *Brit. Med. Journ.*, vol. i. 1889, p. 887), is a most interesting one, the bleeding having come, apparently, from a laceration of the frontal lobe.

A man, aged forty, was admitted into the Great Northern Hospital, December 7, having fallen off a tram-car, when half-drunk. He complained of pain in the left shoulder: there was no evidence of injury to the head. The next four days the patient was very drowsy, and irritable when disturbed. There was no paralysis. December 13, the patient was seized with convulsions. These began in the muscles of the left side of the face, the mouth being drawn up, and the eyelids moved in clonic spasm. The muscles of the neck were next affected, and subsequently the left arm and leg passed into a state of clonic spasm. The breathing was stertorous. The tongue was not bitten. Chloroform having been given, a curved incision was made from the right external angular to the mastoid process. A large flap having been turned down, a crown of bone was removed over the right fissure of Rolando—*i.e.*, about $2\frac{1}{2}$ inches behind and $1\frac{1}{2}$ above the external angle of the orbit. The posterior branch of the middle meningeal ran across the dura mater exposed. This membrane did not pulsate, and appeared to show a black mass beneath it; the artery being secured, the dura mater was incised and a large black clot exposed. About 3 oz. of this having been removed, partly by irrigation, a large cavity could be felt as far as the finger could reach; the brain appeared to be much lacerated over the frontal lobe. The patient ultimately made a good recovery.

TREPHINING AND EXPLORATION OF CEREBRAL ABSCESS DUE TO INJURY.

Indications for Exploring; Symptoms and Diagnosis of Traumatic Cerebral Abscess.—Many of these are given at somewhat fuller length when that form of cerebral abscess which, as one of the results of otitis media, is discussed at p. 204. To begin with, there is the history of an injury.* If no such lesion as frac-

* This may have been a stab with a knife, p. 171, a graze of the head with brief concussion, a fracture, a blow with a stone, a glancing bullet, &c. But the help in the case which the history of an injury gives is not always present, and

ture and depression of the skull exists, and if no laceration, &c., of the brain has occurred, there now often follows a latent period devoid of brain symptoms, which may last from a few—*e.g.*, four—days to three or four weeks or much longer.* This latent period is succeeded by brain symptoms increasing in severity and going on to those of compression—*viz.*, headache felt over the side injured, but not necessarily most intense at the injured spot; nausea or vomiting; some pyrexia, but the temperature usually rises slowly, if it rises above normal at all.†

Other symptoms are mental dulness, the answers long delayed but intelligent when they come, a slow pulse, perhaps rigors, progressive emaciation, perhaps accompanied by vomiting. Whether local nerve symptoms—*e.g.*, disturbances of sensation and motion—are present must depend on the position of the abscess. If the injury has been over the motor area (Figs. 80 to 83), nerve symptoms may be clearly marked; but if over the anterior part of the frontal, or temporo-sphenoidal‡ lobes, they may be entirely absent.

this is an indication for always examining for any wound or scar and exploring it, however unimportant it may seem to be, in these cases. Thus, in the following case (Hulke, *Syst. of Surg.*, vol. i. p. 626), the necrosis might have been overlooked, and the fit and rigidity put down to another cause. A middle-aged woman, having fallen down in a fit, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On her right temple was a small festering wound, leading to necrosed bone. On perforating this with a trephine, pus was forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. A large abscess-cavity was found in the anterior lobe of the right cerebral hemisphere.

* As in M. Dupuytren's and Prof. Nancrede's cases at pp. 171, 172; so, too, in a case of Mr. Hulke's, alluded to in a foot-note, p. 190, the patient, an errand boy, continued to work for seven weeks after the injury, more or less headache being present all the time, retching and hemiplegia then coming on.

† On this point I would refer my readers to p. 205. Prof. Nancrede (*loc. supra cit.*, p. 95) writes thus:—"I believe that an abscess involving the cerebral tissue alone will be accompanied, in most cases, by a subnormal, or, at least, a normal temperature. Where a high temperature is noted, either the pus collection is a localised suppurative arachnitis limited by adhesions, or there is a meningitis in addition to the abscess." Prof. Nancrede quotes briefly a case recorded by Dr. H. L. Brown (*Bost. Med. and Surg. Journ.*, December 29, 1881, p. 610) in which the temperature was 97° for eleven days. Mr. Hulke (*Syst. of Surg.*, vol. iii. pp. 627, 628) gives two cases of cerebral abscess, in which he trephined successfully; the temperature was subnormal in both. More rarely, the temperature shows fluctuations, as in a case of Dr. Burney Yeo (*Brit. Med. Journ.*, 1879, vol. ii. p. 84). More rarely still, the temperature continues high throughout.

‡ With regard to the large collections of pus often found here, Dr. Yeo (*loc. supra cit.*, p. 885) quotes as follows from Hugenin (Ziemssen's *Cyclopaedia*, vol. xii.):—"The difficulty of diagnosis is increased by the circumstance that no bands of fibres, which are direct conductors of sensibility, or motion," pass through this lobe; and, therefore, an abscess here "may attain a considerable size, and may cause general symptoms of compression before any distinct symptom of local disease arouses the suspicion of a localised affection of the brain."

Thus hemiplegia,* a paralysis limited—*e.g.*, of upper limb, and, later on, gradually increasing—epileptic seizures, spasms, spastic rigidity, all have been met with, but must by no means be relied upon, and even when paralysis is present it may escape observation, as when there is slight paralysis of the muscles of the lower half of the left side of the face, and some loss of power in the left hand and arm, but only temporary.†

Finally, the surgeon, who is watching what he believes to be a cerebral abscess, must always remember that after a period of latency, which may last weeks or more, acute symptoms may set in suddenly and quickly close in death.‡

Operation of Trephining for Traumatic Cerebral Abscess.—As the fatality of cerebral abscess, if left to itself, is so high—90 to 100 per cent.—trephining is abundantly justified, but it must be conducted aseptically for fear of setting up suppurative meningitis and brain softening. The chief difficulty is, of course, hitting off the seat of the abscess, especially in cases where there are no definite nerve symptoms to guide, and where the history of the part of the head injured is indefinite also. To obviate the necessity of multiple trephining Dr. Fenger and Dr. Lee, of Chicago, have recommended,§ as easier and safer, exploratory puncture and aspi-

* Mr. Hulke, in relating the case of a boy which he brought before the Medico-Chirurgical Society, March 11, 1879, laid stress on the fact that hemiplegia occurring some time after an injury to the head was significant of disease in the brain itself rather than of arachnitis.

† The value of accurately noting symptoms which, though of but brief duration, may be very important guides in treatment, is well shown by a case of Prof. Macewen's (*Lancet*, 1881, vol. ii. p. 582). A boy, aged eleven, was admitted into the Glasgow Royal Infirmary, two weeks after a fall upon his head, with a partially healed wound and bare bone over the left eyebrow. A week later he had a rigor considered to indicate the probable formation of pus. Five days later, or twenty-six days after the injury, the patient had a convulsion confined to the right side; when this had passed off, he was distinctly aphasic. The seat of the abscess now seemed to be the third left frontal convolution, and trephining was proposed. The friends, however, refused to permit this, as the patient had recovered consciousness, though they were warned that the improvement would be only temporary. Thirty hours later, the convulsions of the right side recurred, the temperature rose quickly from 101° to 104°, and the patient died before the operation could be performed. The situation of the abscess was verified after death.

‡ The sudden cessation of breathing in cerebral cases has been already noticed at pp. 165, 185. So, too, in a case which Mr. Gamgee brought before the Medico-Chirurgical Society, June 14, 1879. A boy, who had been trephined for suspected cerebral abscess, the pus not being found, suddenly ceased breathing the day after the operation. The patient, though apparently dead, being partly revived by artificial respiration, the dura mater and brain were now incised—a step which had not been taken before, as the former structure looked healthy, and did not bulge into the trephine hole—pus welled up, and the child survived for a week. At the autopsy an abscess 2 inches long, and still containing an ounce of purulent fluid, was found in the right frontal lobe; the abscess had burst externally, causing purulent meningitis.

§ *Trans. Amer. Surg. Assoc.*, vol. ii. p. 78.

ration. This must be done methodically with a needle, 4 inches long, set in a large-sized hypodermic syringe. The needle should not be too fine, and the gauge should be powerful enough to make sufficient suction, as a fine needle is readily plugged with brain-substance. This may be easily taken for pus. The needle, well disinfected, is pushed, through a trephine hole, straight in in a definite direction for $\frac{1}{2}$ inch or 1 inch; the piston is then withdrawn a little, and, if no pus follows, the needle is pushed $\frac{1}{2}$ inch further, and the piston again withdrawn. The depth to which it will be permissible finally to push the needle will, of course, vary with the position of the trephine-opening and the direction of the puncture, the surgeon being guided by the anatomy of the brain. The punctures are to be repeated at intervals of $\frac{1}{2}$ inch or 1 inch, the utmost care being taken to push the needle in straight, and to avoid all lateral movements. If, after a reasonable number of punctures no pus is withdrawn, the operator may feel convinced that no pus is present. An abscess in the brain is usually as large as a walnut, often much larger.

Puncturing healthy brain tissue with a fine, perfectly aseptic needle can do but little mischief.

The needle should be kept as a guide till the abscess cavity is definitely opened either by inserting a pair of Lister's sinus-forceps, or a sharp, straight bistoury. From an experience of three cases, I have not found it as easy to keep a drainage-tube securely in the abscess-cavity as it is to find this (p. 209). The abscess-cavity may be washed out with bichloride solution of 1 in 4000, or one of boracic acid; all the fluid injected should be withdrawn.

The following cases of cerebral abscess, in addition to those given at p. 171, and in the foot-notes to p. 189, are good instances of the disease and also of its successful treatment:

A labourer, aged sixty, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when headache, which he had had from the time of the accident, became very severe—so severe that his wife feared he would go out of his mind. On admission the pulse was 56, and the temperature slightly below the normal. The patient's mind was unclouded. About one week later, in the night, he became insensible, and in the morning the right upper and lower limbs were found absolutely palsied as regards motion, and nearly so as regards sensation. When the arm or thigh were severely pinched, he gave scarce any sign of consciousness of it, but shrank slightly when the left limbs were pinched similarly. Two days later, spastic rigidity of the left arm supervened. A small disc of bone cut out beneath the bruised bone on the right temple appeared uninjured. The dura mater bulged up so tensely that pulsation could neither be seen nor felt; its exposed surface appeared healthy. A needle connected with an exhausting syringe was pushed through it to a depth of $1\frac{1}{4}$ inch. A brownish turbid fluid rose up into the receiver, and continued to flow after the needle was withdrawn. The minute opening was enlarged with a scalpel, and a considerable quantity of fluid escaped. The flaps, which had been reflected, were replaced, and the wound

was very lightly dressed with a little boric charpie. An hour later he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation the charpie was wetted and discoloured by the fluid which continued to ooze, but the wound soon healed, and two months after the operation the patient appeared quite well. (Hulke, *Syst. of Surg.*, vol. i. p. 628).

It is interesting to note in the following case that the hemiplegia which followed the operation was only transitory. It also shows that grave symptoms may be latent for as long as five months if a skull wound remains unhealed.

A child, aged four and a half, had sustained a severe compound fracture of the right frontal bone. The removal of some necrosed portions of bone led subsequently to some slight hernia cerebri. The sinus persisted, but the child seemed well in other respects, until about five months after the accident, when left-sided convulsions (chiefly of the muscles of the face and arm) came on, and an alarming condition rapidly developed. The sinus was opened up and a director passed for a distance of 1 inch into the right frontal lobe downwards and backwards. A free flow of fetid pus occurred, and after the cavity had been washed out with carbolic solution (1 in 40), a drainage-tube was inserted. The latter was removed at the end of a fortnight. Left hemiplegia followed the operation, but it passed off some twenty-four hours subsequently. Recovery was rapid and complete.

TREPHINING FOR EPILEPSY AND OTHER LATER RESULTS OF A CRANIAL INJURY.

This is one of the advances in cranial surgery, the results of which have not come up to the expectations formed of it. The operation—one of the most ancient in the history of surgery—after being almost abandoned for centuries, has been again taken up in the last fifteen years with all the advantages of modern surgery. I fear that any candid inquirer, weighing, fairly, unsuccessful as well as successful cases, and attaching due importance to the facts that many of the former have not been published, and that many of the latter have been published prematurely as to final result—*i.e.*, before they have been submitted to the time-test—will come to the conclusion that the result of trephining for traumatic epilepsy is a disappointing one.

It will be worth while to go a little into detail with regard to the grounds which have led me to the following conclusions:

As long ago as 1864, Dr. Hughlings Jackson showed that, in addition to the ordinary idiopathic epilepsy, there was a second class of case, in which the attack began with a sensation in some part of the body, perhaps in one-half of the face or in one extremity. The sensation is followed by a twitching of the muscles of the part, and the sensation and spasm advance gradually from the part originally affected to other parts in definite order. During such an attack consciousness is not usually lost, though it may be lost when the attack culminates in a general convulsion. This form of epilepsy (since known by his

name) Dr. Hughlings Jackson maintained, was uniformly due to organic disease of some kind situated in the convolutions adjacent to the fissure of Rolando. The disease of the brain which gives rise to Jacksonian epilepsy may be of various kinds. "Any affection of the meninges, whether pachymeningitis or leptomeningitis, of traumatic or syphilitic or tubercular origin; or new growths upon or in the cortex of the brain; or cysts formed as the result of small circumscribed hæmorrhages, or of spots of softening from embolism or thrombosis of a cerebral artery; or circumscribed encephalitis or sclerotic patches, may act as centres of irritation in the cortex of the brain. The majority of these forms of disease, when exactly localised in a small area, appear to be traceable to traumatism, either to a blow, a fall on the head, or to a fracture with or without depression" (Starr, *Brain Surgery*, p. 25).

I. Condition of the parts which may be met with during the operation, and which may have originally caused the epilepsy.

(1) **The Scalp.**—Shaving often reveals scars known or undiscovered. When operation was again resorted to in this disease some years ago, it was hoped that tenderness of such scars would be a valuable guide and characteristic of cases to be benefited by operation. Thus, Mr. Walsham (*St. Barth. Hosp. Repts.*, 1883, vol. xix. p. 127) found that, of 82 cases, the scar or spot was sensitive, tender or painful in 42. Pressure in some caused vertigo, convulsions, rigidity or spasmodic twitchings of some groups of muscles. Larger collections of cases have shown that these instances are fewer than was hoped, the share taken in epilepsy by tender scalp-scars being a small one. An instance of these rare cases may be found quoted by Dr. Agnew (*Trans. Amer. Surg. Assoc.*, vol. ix. pp. 16, 17), in which, in a patient operated on by Dr. T. S. Miller with success, a branch of the great occipital nerve was found caught in an old fracture. In 8 out of the 44 cases collected by Mr. Walsham a sinus was present leading down to bare bone.

(2) **The Periosteum.**—This may be found extremely thickened, and very closely adherent to the bone. Excess of vascularity may also be met with. Osteophytic deposits have not been met with.

(3) **The Skull.**—Lesions of all kinds have been met with. Depressions, fractures, fissures are very common. From the inner table a spiculum or exostosis* may project inwards. With regard

* The term exostosis is sometimes applied to the depressed bone; this, when circumscribed and osteophytic, is easily dealt with. An allied condition, rarer, and one much more difficult to deal with, is described by Dr. Echeverria (*Arch. Gén. de Méd.*, 1878, t. ii. p. 533). A conical, irregular projection of bone, measuring $2 \times 2\frac{1}{2}$ inches, here compressed the dura mater and brain, being situated very close to the superior longitudinal sinus, just to the left of the occipital protuberance. In trephining, the crown entered into this exostosis, the removal of it proving most laborious, the operation lasting three and a half hours. The

to these last conditions, it is very noteworthy that in one of the cases collected by Mr. Walsham, though nothing was detected at the operation, a spiculum was found at the autopsy not far from the trephine-hole, this pointing to the advisability of sweeping a probe carefully and with aseptic precautions so as to explore the parts at some distance from the circumference of the opening. Another point which is of great importance with regard to the indications for trephining as given by the state of the skull is this: several cases have been recorded which prove that it is not always safe in trephining for epilepsy to rely on the position of a fracture, unless that fracture coincides very closely with the spot selected for trephining from the character of the fit. Thus, in two cases related by Dr. Starr (pp. 30, 32), depressed fractures existed, epileptic attacks had developed subsequently to them, but the fit, which began in both patients in the arm, indicated disease in the middle third of the motor area, while the position of the fracture was upwards of two inches away from this spot.* In another case, where the surgical indication or position of the fracture was neglected, and the medical one or the evidence given by the fits was followed, this proved to be the correct one, as on raising the button of bone a splinter from the internal table was found penetrating the dura mater and brain, though at the spot selected there was no evidence of fracture.

4. **The Membranes.**—Both the dura and pia mater may be found much thickened, blended with each other and adherent to the cortex. In some cases they form respectively the outer and inner wall of a cyst.

5. **The Brain.**—When pathological changes are present in the part explored, the cortex may be found compressed or indented, stained, sclerosed or softened. Cysts in the cortex, perhaps the result of old hæmorrhage, are not uncommon.†

patient recovered. A case of Kochler's, of Berlin (*Deutsch. Med. Woch.*, No. 46, 1889), illustrates a less localised condition. A sword-cut had injured the bone, without depression. Epileptic fits followed in six weeks. About a year later trephining was successfully performed. The dura mater was adherent, the bone much thickened and covered with thorn-like processes pressing on, but not perforating, the dura. Good illustrations of a blunt spiculum from the internal table are given by Dr. Williamson and Mr. Jones (*Brit. Med. Journ.*, vol. ii. 1889 p. 919). Seven months after the operation the fits recurred. An open sinus which had persisted being explored, a small spicule of necrosed bone "projecting downwards" was removed. Up to the last report recovery was complete.

* Such cases emphasise the need of sweeping a probe around the margins of the trephine-hole, so as to explore the neighbourhood thoroughly.

† In the first of the following cases (Echeverria, *loc. supra cit.*, p. 535) an old hæmorrhage was present. The patient, aged twenty-two, had, ten years before fractured his right parietal bone. Epileptic fits began six months after the injury, and their increasing frequency was associated with an extreme degree of idiocy, the patient being, on admission, a mere automaton, without intelligence or memory. On the seat of fracture being explored, a kind of pouch was found embracing an old blood clot. When this was turned out, the hæmorrhage was

In many cases no lesion is found. In such, before deciding that nothing abnormal is present, the precaution given at p. 94 should be taken: where no lesion is found either at or near the place of injury, mischief may still exist in other parts of the brain, eluding diagnosis and treatment, as long as it gives no local symptoms of its existence.

Results of Operation.—Later collections of cases and (what is of paramount importance) keeping cases more carefully under after-observation, have shown that operations for traumatic epilepsy have not come up to the expectations formed of it. Thus Prof. Agnew (*Trans. Amer. Surg. Assoc.*, 1891, vol. ix. p. 15) gives results in 57 cases operated upon at Philadelphia. Of these 57 cases, 4 died (a mortality of 8·77), 4 were cured, 4 were operated upon too recently to venture an opinion, 4 passed out of observation, 32 experienced temporary benefit, 9 obtained no relief. Of the 4 reported as cured, Prof. Agnew is careful to point out that 2 had not been under observation longer than 10 months, a period quite inadequate to allow us to speak with any confidence as to the final result, as in one case of Prof. Agnew's a year, and in one of Dr. White's 20 months, had elapsed after the operation before the fits recurred. In 52 American cases collected by Dr. Starr, (*loc. supra cit.*, p. 28), 13 being under his own observation, 13 were cured, 11 improved, 15 not improved, and 13 died. Here, also, in several instances, the time that had elapsed between the operation and the date at which the case is reported is quite inadequate.*

Starr (p. 112) says as to the result in these cases: "It is

so free as to require the actual cautery. The intellectual faculties were largely restored by the operation, and the fits were also much reduced in frequency. The death of the patient took place, nearly nine months later, from meningitis, apparently due to exposure to the sun. An autopsy showed that the clot-containing cavity was in connection with the brain-membranes, and apparently continuous with one of the branches of the middle meningeal artery. In the second, a cyst was also the cause of the mischief. Thus (*Ann. of Surg.*, vol. iii. No. 6, p. 522; *Amer. Journ. Med. Sci.*, April 1886), after a pistol-shot wound of the skull, about $\frac{3}{8}$ inch from the middle line, and $1\frac{3}{8}$ inch from the hairy scalp, aberration followed, culminating in marked insanity. The depression in the forehead being explored by a crucial incision, an opening in the skull was discovered, closed by fibrous material. In the expectation of finding an abscess-cavity, the needle of a hypodermic syringe was thrust through here in several directions until the barrel was found to be filling with a serous fluid, all of which was withdrawn to the extent of about 2 drachms. On emerging from the anæsthetic, the patient was found to have fully regained his mental equilibrium, in which condition he remained five months later, the wound having quickly healed.

* Dr. Laurient has collected 162 cases of trephining for traumatic epilepsy (*Journ. de Méd. de Chir. et de Pharmacologie*, May 20, 1891) with the following result. About half are claimed as cures, but it is admitted that the time that had elapsed since the operation is too short to decide as to the ultimate benefit received.

evident that in the majority there has been a failure to permanently cure epilepsy by operative interference. When we raise the question why the operation has failed, the obvious reply is that the original condition which gave rise to the fits has not been removed. This is evident from a study of the pathological changes already enumerated. It is, of course, quite possible to elevate depressed bone, to remove a cyst, or to take away any mass of connective tissue or tumour which compresses the brain. But, on the other hand, it is useless to break up adhesions between the dura and pia or between pia and brain, because they will inevitably reform after the operation. . . . Fine trabeculae of connective tissue entering the cortex from the pia, and forming a dense scar tissue in and about the motor cells, give rise to an irritation which can only be removed by the excision of the mass. But excision of such a mass together with the brain, or excision of a softened mass of brain, is inevitably followed by a formation of a connective-tissue cicatrix which, in turn, will act as an irritant. . . . I think the fact that the underlying organic brain disease producing the epilepsy cannot always be eradicated by an operation fully explains the failures which have been recorded by so many observers. . . . But when it is taken into consideration that in no case is it possible without an operation to determine the exact pathological condition present, and that a certain proportion of the pathological conditions are removable, it is evident that an operation, if not attended with danger, may be reasonably undertaken." Prof. Agnew, from the statistics of the Philadelphia surgeons, was also of opinion that Surgery would do but little for traumatic and Jacksonian epilepsy. He held that the treatment must be mainly preventive. "It is not saying too much to assume that surgery is responsible for the great majority of traumatic epileptics, and though this statement does not by any means criminate the surgeon of an early day . . . the doctrine that depressed fractures of the skull without symptoms required no operative interference I hold to be responsible for many, very many, of the unfortunate sequelae of head injuries. However small may be the depression which follows a fracture of the cranium, save in one or two localities, it will encroach enough upon the dural nerves to cause more or less irritation; though insignificant at first and not at all recognisable to the consciousness of the patient, yet eventually that irritation will be propagated to the meninges, and later on to the cortex and brain ganglia, until finally the paroxysmal explosion occurs; and then, even when the initial lesion is removed, the slowly established habit, created by years of excitation, will remain as an ineradicable legacy. No amount of foresight can determine what happens to the inside of the skull, after an injury, by an inspection of its exterior surface. Whenever, therefore, the profession can accept the doctrine that all depressed fractures of the cranium, however slight the depression, and entirely independent of pressure symptoms, are proper subjects for trephining, then

will traumatic epilepsy largely disappear from the list of surgical diseases."

Operation.*—To begin with, a painful cicatrix† may be freely excised. This may be done with some hope that nothing further in the way of operation will be required in cases where the scar is constantly painful, tender, or hot; where it corresponds to the course of some known nerve, and in any case where the original wound was lacerated, or contused, and slow in healing, and where there is any chance of a splinter of wood or metal being embedded in the scar.‡

If it be necessary, as it usually is, to remove a crown of bone, an appropriate semilunar flap (pp. 173, 244), must be reflected with the aseptic and other precautions already given. Hæmorrhage being arrested, and the flap retracted by Spencer Wells' forceps, the pericranium is carefully divided and turned off the bone,§ and its condition noted as to thickening and other evidence of old inflammation. The bone being thoroughly exposed, the surgeon must be prepared for the following conditions—viz., the line of an old fracture, necrosis (indicated by a sinus with prominent granulations), hypertrophic sclerosis amounting, in some cases, to eburnation, and, on the under surface, depressed fragments of the internal table, spurs, or nodules of bone. Any sequestrum will of course be removed. If the surgeon finds it needful to resort to trephining, he will do so with the precautions given at p. 174, remembering that here he is especially likely to be dealing with a crown of bone of varying density at different points of its circumference.|| It must be elevated with particular caution, as a spicule

* During this, the surgeon must be on his guard for the sudden supervention of epileptic seizures or convulsive movements of one limb—e.g., when he is raising a crown of bone much thickened and adherent to the dura mater.

† Prof. Briggs (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 116), in a most excellent paper, in which large personal experience throws much light upon the subject, speaks of having had five such cases. After thorough removal of the scar, the wound was left to heal by granulation; in all the attacks were arrested. In one of Dr. Echeverria's cases (*loc. supra cit.*), convulsions, vertigo, &c., were cured by the removal of a small fibroma adherent to the frontal periosteum and supra-orbital nerve. Dr. Starr's opinion (*loc. supra cit.* p. 68) on the other hand is much less favourable. "From my experience I consider that true reflex epilepsy from scars in the scalp is a very rare occurrence."

‡ Dr. Johnson (*Clin. Soc. Trans.*, vol. vi. p. 35) records a case where trismus, facial neuralgia, and paralysis, with a recurrence of epilepsy (the patient, aged forty-four, had been free from fits for twelve years), were caused by a sharp, angular piece of flint, embedded in a painful cicatrix of the cheek, the removal of which was followed by complete recovery.

§ Or this structure may be raised together with the flaps.

|| Free and most embarrassing hæmorrhage may be met with in sawing through altered diploë traversed by large sinus-like venous channels, requiring firm pressure during and after the operation, plugging with a tiny, wooden aseptic peg, or crushing the bone together with forceps at the bleeding point.

may have made its way through the dura mater and be pressing on the brain.*

If the first crown shows nothing abnormal, a probe should be gently inserted between the bone and dura mater and carefully swept around, so as to give information of the condition of the inner surface of the surrounding bone. If the first crown show changes which are, however, not localised to it, the trephine must be applied again till all thickened bone capable of exerting pressure on the brain and its membranes is removed.†

If no change can be found in the crown removed, or in the surrounding bone, what more should be done on this occasion? If there be reason to suspect abscess in the brain, because the symptoms of this condition (pp. 189, 204) are present, or because the dura mater bulges up without pulsation‡ into the trephine-hole, the treatment should be as directed at p. 191.

Most strict antiseptic precautions§ (p. 243) should be made use of before and during the operation, sufficient drainage should be provided, and, in bringing the flaps together, the drainage-tube must not be pressed upon or closed. Great care must be taken to keep the wound sweet later on, putrefaction leading to septic softening and hernia of the brain. If it has been needful to remove much bone, some of this should be preserved and replaced with the precautions given at p. 176.

Causes of Failure after Trephining for Traumatic Epilepsy.
—Amongst these are :

1. Not hitting off the right spot.—A bony spiculum, undetected at the operation, has been found, post mortem, not far from the trephine-hole (p. 194). To meet this contingency, it has been advised to sweep a probe carefully round the circumference of the trephine-hole, and at some distance from it.

* In one case Prof. Briggs (*loc. supra cit.*, p. 106), on elevating the bone, found that a spicule of bone from its under surface had penetrated the superior longitudinal sinus. The hæmorrhage was arrested by sponge-pressure, and the patient made a good recovery. In such a case, the sponge should be carefully disinfected and dusted with iodoform (p. 169).

† Prof. Briggs (*loc. supra cit.*, p. 118), speaking of one case in his practice, says that six large crowns of the trephine were found necessary to surround and separate the thickened and roughened bone, which, after the angles were rounded off with a Hey's saw, left an opening as large as the palm of the hand. The patient is stated to have been cured.

‡ In a case of Dr. Oliver's (*Lancet*, 1887, vol. ii. p. 1183), the dura mater pressed up tensely through the wound. An incision was followed by a few teaspoonfuls of serum containing shreds of fibrin. For a day after serum continued to escape amounting to about 2 or 3 ounces.

§ Dr. Billings (*Amer. Journ. Med. Sci.*, July 1861) has collected 72 cases of epilepsy trephined, with a mortality of 16. In proof of the importance of the above precautions, Dr. J. Russell (*Brit. Med. Journ.*, 1865, vol. i. p. 582) gives 80 cases with 44 recoveries, while more recently Dr. Briggs (*loc. supra cit.*) has trephined 28 cases of epilepsy with only 1 death.

2. A general* and diffuse thickening of the bone round the site of injury (*vide* p. 198, and foot-note, p. 194).

3. Owing to the long continuance or to the amount of the irritation, the brain may be permanently affected. Thus, in words already quoted (p. 167), there are cases of depressed fracture in which "the constant irritation has begotten a permanent impression upon the brain and nervous system which remains after the offending point of bone has been removed." The grosser and more localised the lesion, the more speedy will be the relief. As long as the fits are diminished in number and severity, the prognosis is still hopeful. The fits may be very slow in disappearing. The supervention of insanity is, of course, very grave.

4. Idiocy or mental weakness persisting.—From alterations in the membranes or brain itself too extensive for removal.

5. Neglect of after-treatment, both medical and surgical, but chiefly the former.—Prof. Nancrede's words (*Intern. Enc. Surg.*, vol. v. p. 102), are worthy of remembrance: "The operation, indeed, removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the nervous system, can only disappear with time, and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly, if at all, benefited, whereas, judicious after-treatment will sometimes relieve an apparent operative failure."

6. Trephining for fits not epileptic in character.—Mr. Hulke† gives a most interesting account of a case in which he trephined for "anomalous" convulsive attacks supervening several months after a head injury.

The operation, while it did no harm, was useless. Bromide and iodide of potassium having been tried in vain, a full trial of valerianate of zinc was made, the fits subsiding under this treatment. This fact, the way in which the fits came on, the slight degree of unconsciousness, its gradual onset, and the fact that occasionally the first convulsion had the aspect of purposive movements, supported the view that the fits were not epileptic, but hysterical, induced by the shock of an accident in a person of unstable nervous system. On the other hand, the traumatic origin, the headache, the darting pain on touching the part injured, were all suggestive of some chronic irritative process, and justified the operation of trephining.

7. A septic condition of the wound, almost invariably the fault of the surgeon, and bringing about (a) meningitis, (b) hernia cerebri, (c) cerebral abscess.

* Nothing but a general thickening of the bone was found in a case of Mr. Clark's (*Lancet*, 1886, vol. i. p. 243). The cure was ultimately complete, though tardy.

† *Med. Times and Gaz.*, 1881, vol. ii. p. 85. It is noteworthy that the bone removed, and the dura mater in this case being normal, an aspirator-needle was pushed through the latter to the depth of an inch, and then withdrawn, as nothing escaped through it. For a few minutes, owing to the high intra-cranial pressure, cerebro-spinal fluid spirted in a slender stream for the distance of nearly a foot, and continued to leak away for several hours.

8. Shock.

Finally, in cases of doubt, and where the operation has failed, the interference of the surgeon will be justified by the fact that traumatic epilepsy tends to grow worse, and is little affected by medical treatment. In the words of Echeverria (*loc. supra cit.*, p. 551), once declared, traumatic epilepsy, due to injury to the head, leads to early insanity or to feebleness of intellect.

Accidents during the Operation.—Perhaps the fault of the surgeon—viz., (1) middle meningeal hæmorrhage (p. 186); (2) hæmorrhage from an open sinus (p. 169).

TREPHINING FOR MASTOID ABSCESS AND CEREBRAL ABSCESS, THE RESULTS OF OTITIS MEDIA

(Figs. 74 to 77).

POINTS OF PRACTICAL IMPORTANCE TO THE SURGEON IN THE ANATOMY OF THE PARTS CONCERNED.*

I. *Tympanum*.—(a) Roof always thin, not more than a line and a half in thickness, often thinner.† Through this inflammation in otitis media readily reaches the brain, causing meningitis, sub-dural or cerebral abscess. (b) Parts of the brain and cerebellum which are in contact with middle ear. These are the middle and back part of the temporo-sphenoidal lobe, and the outer and front part of the lateral lobe of the cerebellum. With regard to this latter site of abscess, Mr. Toynbee (Fig. 74), held that the greater frequency in adults of cerebellar abscess and, with this, of thrombosis of the lateral sinus were due to the development of the mastoid cells backwards. (c) The mucous membrane and the endosteum lining the tympanum are in most intimate contact; hence, in otitis media, caries and necrosis readily occur, especially if the blood-supply to the tympanum from the dura mater is cut off. (d) The skin of the external auditory meatus is continuous with the membrana tympani, and thus otitis media may be set up from without, as well as by mischief reaching the tympanum through (e) the Eustachian tube, which enters in front, and makes the mucous membrane of the throat continuous with that of the tympanum. (f) The outlets of the mastoid cells and of the tympanum are inadequate for drainage in otorrhœa, as many of the mastoid cells lie below the level of their opening into the tympanum, and the floor of the tympanum is, in part, below the orifice of the Eustachian tube. Decomposition is thus favoured.

II. *Mastoid Cells*.—(a) Their development varies with age. In adults, if well marked, they may measure $1\frac{1}{2}$ inch horizontally, 2 inches vertically, and reach quite up to, and even around, the lateral sinus (Fig. 74). (b) Two groups of cells are present; (1)

* These should be studied together with a skull and one or two sections of a temporal bone, somewhat similar to that shown in Fig. 74.

† The bony roof is occasionally absent.

The horizontal, which are closely adjacent to the back of the tympanum, and communicate with it. This group constitutes "the antrum," and is present both in early and late life. Their size is that of a good-size round pea, or after puberty, that of a small marble. The antrum is bounded externally by that part of the squamous bone which is immediately behind and above the external meatus. Through this bone, extremely thin in early life, pus from the tympanum may make its way externally. After the second year it becomes much thicker, and this mode of exit may be cut off. It is through this bone that the trephine or gouge should be directed in opening up the mastoid cells. (2) The vertical. These are not developed in earlier life; later on their presence brings pus

FIG. 74.



A section of a temporal bone showing the mastoid cells, both horizontal and vertical, with the close proximity of the lateral sinus, which is seen to the left and above. (Toynbee.)

nearer the lateral sinus and cerebellum (*vide supra*). (c) The contents of the cells vary a good deal, being in some air, in others marrow. In yet a third class the cells are largely obliterated by old sclerosing otitis. (d) The passage of veins from the tympanum and mastoid cells. These fall into three chief groups: (1) those opening into the lateral sinus; (2) those passing through the mastoid foramen into the occipital vein and soft parts outside the skull; (3) those running through the petro-squamosal suture to the dura mater. All these veins carry sheaths of connective tissue, and thus inflammatory products may reach (a) the lateral sinus, causing septic phlebitis; (b) the soft parts outside, causing periostitis, cellulitis, &c.; (c) the dura mater and brain, causing meningitis and abscess.

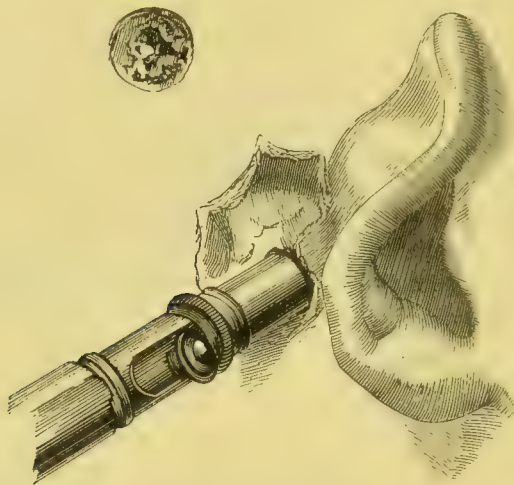
FOUR RESULTS OF OTITIS MEDIA WHICH MAY COME UNDER THE NOTICE OF THE SURGEON.—(i.) Acute inflammation of mastoid cells: mastoid abscess; (ii.) abscess in brain or cerebellum;

(iii.) septic thrombosis of sinuses and pyæmia; (iv.) meningitis.* N.B.—The above four often co-exist, and thus the symptoms may be much blended together and confusing.

(i.) ACUTE INFLAMMATION OF MASTOID CELLS: MASTOID ABSCESS.—*Symptoms.*—These vary much. The more the periosteum over the mastoid process is involved, the more clear are the symptoms and the more certain will be the relief from a sufficient incision. The less the periosteum and the soft parts are involved, or the more altered the bone by old sclerosing otitis due to prolonged irritation, the less evident and decided are the symptoms, the less likely is an incision alone to relieve.

Indications for interfering by Incision or Trephining.—History of old otitis media,† with long-continued discharge and deafness.

FIG. 75.




Trephining the mastoid cells. The auricle is drawn forwards. The direction of the trephine is too much upwards. Above is shown the under surface of the disc of bone removed, with the cells opened.

The discharge may have ceased owing to a plug of caseous pus or granulations, or increased owing to some blow, exposure to cold, use of instruments, or some independent pyrexia. Pain in and behind the ear, over the temple or occiput, unrelieved by ice, leeches, fomentations, &c. Mastoid tenderness, swelling, redness, œdema. N.B.—The last three are by no means always present in mastoid abscess. Discharge fetid, and unrelieved by washing out

* According to Poulsen (*Arch. of Otol.*, July 1892, p. 346) the relative frequency of the latter three complications is about the same. Thus, out of 36 cases of complications of otitis media there were 13 cases of abscess, 12 of sinus-thrombosis, and 11 of meningitis.

* Mr. Barker drew attention to the much greater gravity of old-standing cases. Thus otorrhœa does not cause cerebral abscess till it has lasted months or years. In only two of the cases which Dr. Pitt collected in his *Gulstonian Lectures*, 1890, was the duration of the otorrhœa under a year.

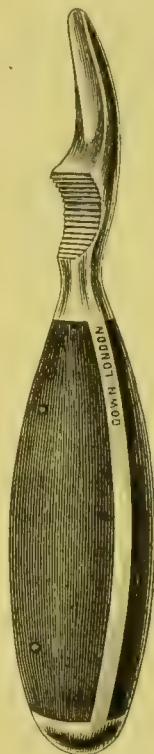
every hour with lotions, *e.g.*, mercury perchloride (1 in 4000), saturated boracic acid, &c., followed by the insufflation of Jeyes' dusting-powder or boracic acid, finely powdered, 3 parts, iodoform 1 part. Drowsiness, torpor, but absence of the graver symptoms, pointing to cerebral abscess, pyæmia, or meningitis (pp. 189, 204).

Trephining the Mastoid Cells.—The parts being shaved and cleansed, and an anæsthetic cautiously given, a free incision is made with a strong-backed scalpel down to the bone from the base to the apex of the mastoid process, immediately behind the auricle, and converted into a . Such a gouge as that shown (Fig. 76), or a small trephine, is applied immediately behind the auricle (Fig. 75), on a level with the external auditory meatus, and directed forwards and inwards, especially in children, owing to the close proximity of the lateral sinus. After working for $\frac{1}{4}$ or $\frac{1}{2}$ inch, the instrument will be found to have penetrated the cells. These are then to be freely opened up with a gouge, cleansed as far as possible by removing all caseous pus and foul granulation tissue with a sharp spoon (I have found a small-sized Marshall's osteotrite most efficient and speedy in enlarging the opening first made), and disinfected by the use of the lotions and powder given above. When the cells have been thoroughly exposed—for it is unsatisfactory and dangerous to work in a cramped conical pit-like cavity—a blunt-pointed probe should be used as a guide into the tympanum, and the communication between this and the antrum cautiously opened with a sharp spoon or a steel director. The presence of a probe thus passed into the tympanum from the antrum can be detected by the passage of another from the meatus if the membrane be perforated, as is almost certain to be the case, and the sufficiency of the communication will be made plain by the exit from the meatus of fluid syringed through the antral opening. But with regard to this syringing, caution is necessary if the Eustachian tube be patent, and only boracic-acid lotion or boiled water should be used.

It is well to insert a drainage-tube securely in the opened-up antrum. If bleeding is severe, strips of iodoform gauze wrung out of carbolic-acid lotion (1 in 20) should be plugged in around the tube. A thick dusting of iodoform or Jeyes' powder is then applied, and any of the usual aseptic dressings.

As the cells are somewhat complicated, and their contents often most fetid, a thorough opening up is urgently required. The gouge is, of course, to be preferred to the trephine in enlarging an

FIG. 76.



An excellent form of gouge, comfortable for prolonged handling, and adapted for use with the mallet.

opening, *e.g.*, towards the lateral sinus. When the bone is densely sclerosed, the use of a small trephine will be found more speedy. If directed properly it is absolutely free from danger. Whichever instrument is chosen, it must be used thoroughly and efficiently for the complete disinfection of the cells, the persistence of a sinus, soon becoming fetid, meaning an incomplete operation. Again, if the wound heal and headache return, some head of fetid pus is probably pent up in an unexplored mastoid cell. The whole of the outer wall (p. 201) of these cells of the antrum should be removed.

Hæmorrhage during and after the operation* is occasionally troublesome, especially when the tissues are soft and almost rotten, and ligatures difficult to apply. Such hæmorrhage is best met by firm pressure, or by leaving on Spencer Wells' forceps.

Thus, in one case, after successful opening of the mastoid cells, in a patient admitted with erysipelas of the scalp and mastoid abscess, secondary hæmorrhage took place from the posterior auricular artery. The tissues not holding a ligature, and breaking away with torsion, I applied a pair of the above-named forceps. When they came away on the fifth day no further hæmorrhage had taken place, and the case made a good recovery.

Venous hæmorrhage may be extremely profuse during the operation, though the instrument has never been allowed to trench on the area of the lateral sinus; such bleeding will yield to firm pressure.

The possibility of injury to the facial nerve, as it lies on the inner wall of the tympanum, must also be borne in mind. Mr. W. Arbuthnot Lane, in one of his interesting papers on the results of Middle Ear Disease (*Brit. Med. Journ.*, 1890, vol. i. p. 708), draws attention to this danger. In one of his patients,

On the third day after the operation some paresis of the facial muscles was observed. This became more marked, then subsided and disappeared within ten days of its onset. It was obviously due to inflammation set up by the operation, and not to any injury of the facial nerve in the bone.

Again (*loc. supra cit.*, p. 1480) Mr. Lane writes: "If, after opening the antrum freely, a fine probe can be passed through it into the middle ear, one has the satisfaction of knowing that one can remove any portion of the bone external to the probe without risk of damaging a very important structure."

(ii.) ABSCESS IN THE BRAIN OR CEREBELLUM.—(A) When in the brain, the collection of pus is usually in the middle and back part of the temporo-sphenoidal lobe; (B) when in the cerebellum, in the front and outer part of the lateral lobe.

Symptoms.—These are often rather negative, no special nerve symptoms being called out in the above regions, as is the case with an abscess in the motor area. There is a history, perhaps, of

* If the lateral sinus has been accidentally opened, and is healthy, the treatment must be that given at p. 169. This complication is, however, a serious one, owing to the difficulty of keeping the wound sweet, and thus of preventing septic phlebitis.

mastoid suppuration, with the symptoms given above, unrelieved by treatment. A latent period, in which headache, vomiting, and a dull, heavy mental state are usually present, is followed by a more urgent stage. Amongst the most important symptoms of this are agonising headache; * drowsiness, deepening into coma; while power of speech remains, the answers are unwillingly given, delayed, but intelligent; "sluggish, but perfect cerebration" (Barker, *Lancet*, 1887, vol. i. p. 1177); vomiting (this is occasional, or ceases after a day or two), not constant and incessant; one or two rigors may occur at the commencement of the abscess-formation, but they are not commonly repeated in an uncomplicated case of abscess; the temperature is rarely high in cases uncomplicated with meningitis or thrombosis, often subnormal—*e.g.*, 97°, and falling; the pulse slow—*e.g.*, 65–50; optic neuritis; † progressive emaciation; obstinate constipation. Hemiplegia, ‡ paralysis of face, ptosis, alteration of pupil, are either absent or present only later on. The following symptoms are most grave, and point to a fatal termination being not long delayed—*viz.*,

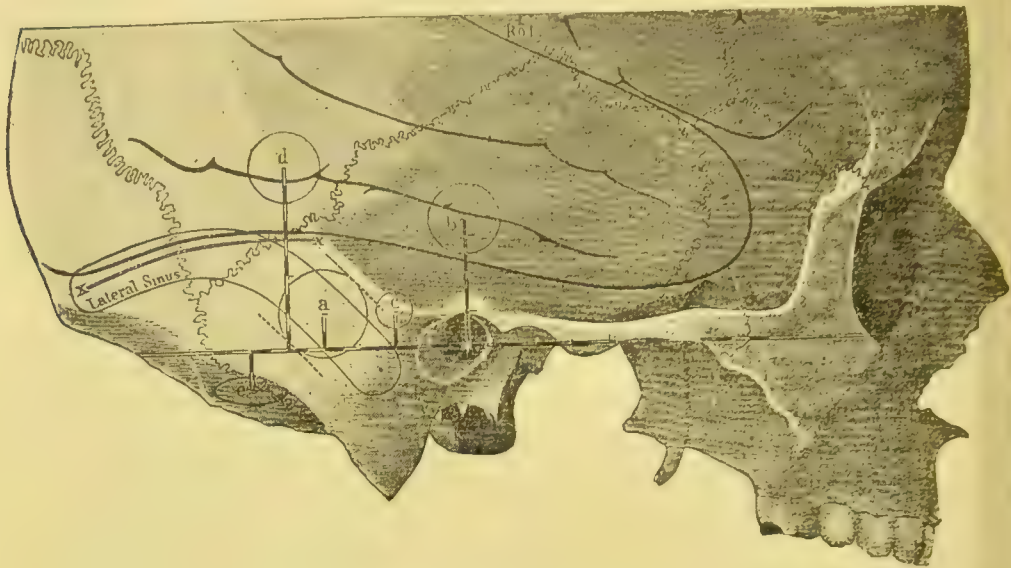
* Dr. Pitt (*loc. supra cit.*) considers that the two most characteristic symptoms are "a headache of intense severity, and a dull, sluggish mental state."

† It seems at present unsettled to what condition, thrombosis, meningitis, &c., this symptom is chiefly due. Thus, Dr. Pitt (*loc. supra cit.*, lect. i.) holds that well-marked optic neuritis is more suggestive of sinus thrombosis than of other lesions; further, that it is unfrequent in cerebral abscess, and is often in such cases due to a complication. Messrs. Lawford and Edwards (*Ophth. Soc. Trans.* vols. iii., iv., v., and vii.) believe that in all cases of optic neuritis of intra-cranial origin, the affection of the optic nerves is due to an extension of inflammation to their sheaths from inflamed pia mater, and that, therefore, optic neuritis in these cases is diagnostic of basal meningitis. Mr. Ballance (*Lancet*, 1890, vol. i. p. 1116) is of opinion that optic neuritis "points to the fact that the dura is already sloughed, or is involved in inflammation sufficient to produce slight basal meningitis as far forward as the optic nerve." For my own part, I do not think we are yet in a position to draw conclusions as to this point and several others usually given as indicative of cerebral abscess. While optic neuritis is certainly met with in abscess, meningitis, and thrombosis, it may be present in mastoid inflammation without any cerebral abscess or other known complication save otitis media, and may persist for a long time after the case has been successfully treated by trephining; this occurred very markedly in a case which I was asked to trephine by Dr. F. Taylor in his wards at Guy's Hospital. Another point is, I think, certain—that if optic neuritis persists after a cerebral abscess has been opened, and all seems to be doing well, it is evidence that the cavity is not completely drained. Persistence of the neuritis was a very marked feature in the case mentioned later, in which, after trephining and finding a very large temporo-sphenoidal abscess, I had on two later occasions, many weeks after, to let out re-collections of pus. Here it was not until long after the first operation, the wound being now healed, and the patient for some time up and about to leave the hospital, that Dr. Goodall, the medical registrar, reported, "On Aug. 2 (five and a half months after the first operation) there was a little indistinctness of the inner edge of the right disc (the abscess had been on the left side), otherwise both discs were normal."

‡ I should look upon this as of grave omen, and indicating that the abscess has either burst or is about to do so into the lateral ventricle.

lividity, irregular pulse, tracheal râles, pulmonary crepitation, incontinence of excreta, tremors, and cervical swelling along the internal jugular vein (p. 210), and, of course, evidence of pyæmia or meningitis, these conditions often co-existing.

FIG. 77.



The figure shows the relations of the lateral sinus to the outer wall of the skull, and the position of the trephine-opening (a) for exploring it. Reid's base-line is shown passing through the middle of the external auditory meatus and touching the lower margin of the orbit. xx indicate the site of the tentorium as far as it is in relation to the outer wall of the skull. The anterior x shows the point where the tentorium leaves the skull and is attached to the upper border of the petrous bone. (a) Trephine-opening to expose lateral sinus, its centre being 1 inch behind and a $\frac{1}{4}$ inch above the centre of the meatus. This opening can easily be enlarged upwards, backwards, downwards, and forwards (see the dotted lines), by suitable angular forceps. It is always well to extend it forwards so as to open up the mastoid antrum (c). (b) Trephine-opening to explore the anterior surface of the petrous bone, the roof of the tympanum, and the petro-squamous fissure, its centre being situated a short inch above the centre of the meatus. At the lower margin of this trephine-opening a probe can be insinuated between the dura and the bone, and made to search the whole of the anterior surface of the petrous. (c) Trephine-opening for exposing antrum $\frac{1}{4}$ inch above and behind the centre of the meatus. (d) Trephine-opening for temporo-sphenoidal abscess (Barker) $1\frac{1}{4}$ inch behind and above centre of meatus. The needle should be directed at first inwards, and a little downwards and forwards. (e) Trephine-opening for cerebellar abscess $1\frac{1}{2}$ behind and $\frac{1}{4}$ inch below the meatus. The anterior border of the trephine should be just under cover of the posterior border of the mastoid process. Such an opening is well removed from the lateral sinus, and a needle if directed forwards, inwards, and upwards, would enter an abscess occupying the anterior portion of the lateral lobe of the cerebellum, the usual site of an abscess in this part of the brain. (Ballance.)

Treatment.—Early aseptic trephining: sites (A) *In the Brain.*—Mr. Barker (*Brit. Med. Journ.*, December 11, 1886) thinks that nine-tenths of abscesses in the brain lie within a circle with a $\frac{3}{4}$ -inch radius, whose centre lies $1\frac{1}{4}$ inch above, and the same

distance behind, the centre of the bony meatus (Fig. 77).^{*} This corresponds to the posterior inferior angle of the parietal bone, and the lower and back part of the temporo-sphenoidal lobe, and over the above central point the trephine should be applied.

(B) *In the Cerebellum*.—Mr. Barker (Fig. 77) advises a point $1\frac{1}{2}$ inch behind the centre of the meatus and 1 inch below the base-line (a line running from the lower border of the orbit backwards through the centre of the meatus—Reid). This point is well behind the vertical and well below the horizontal part of the lateral sinus, while it gives easy access to all the anterior third of the lateral lobe, in which the pus is invariably found. I would remind my readers that cerebellar abscesses are much smaller than those in the temporo-sphenoidal lobe.

Owing to the far greater frequency of temporo-sphenoidal abscess, most of the above remarks apply to the treatment of cerebral abscess. While many of the symptoms given at p. 205 are common to cerebral and cerebellar abscess, it is possible that the following may help in distinguishing the two. Dr. Edgeworth (*Bristol Med. Chir. Journ.*, June 1890) thinks that in slowly enlarging, uncomplicated cerebellar abscess reeling gait and vertigo (from pressure on the middle lobe), and tenderness on percussion over the cerebellum will be helpful in diagnosis.

Dr. Bryden (*Brit. Med. Journ.* vol. i. 1890, p. 710) publishes a case of cerebellar abscess following on chronic otitis media, in which the only prominent symptom was the constant twitching of the facial muscles on the same side. The same writer calls attention to the fact that Nothnagel has stated that mechanical irritation of even the surface of the cerebellum gives rise to movements without pain of the muscles governed by the fifth, facial and hypoglossal nerves.

Prof. Macewen, in a most instructive case, in which the patient was saved by trephining from the very gravest peril brought about by a cerebellar abscess, gives the following points as useful in the diagnosis. "The rigidity of the masseters, the very frequent yawning, the mechanical opening and shutting of the mouth, the difficult jerky articulation, the excessive lowering of the circulation and respiration, pointed to a lesion of the cerebellum involving the medulla, while the brachial monoplegia on the same side indicated a lesion below the decussation of the nerve tracks. Blindness is so frequent a sequel of large cerebellar tumours that it also pointed to the location of abscess as cerebellar, and to one probably of large size" (*loc. supra cit.*, p. 200). At p. 196 the same writer draws attention to the fact that in cases of pressure in the cerebellar fossa, implicating the medullary respiratory centre, the respiration may be gravely imperilled. Further, that cerebellar

^{*} *Man. of Surg. Operations*, p. 400. In children I think it wiser to keep nearer to the ear—i.e., to place the trephine no further than an inch behind and the same distance above the meatus. Otherwise there is danger of opening the lateral sinus.

abscess may cause great ventricular distension and accompanying œdema. A little increase in the above conditions—*e.g.*, when an anæsthetic is given, may easily bring about a fatal result.

Where the diagnosis between a cerebral and a cerebellar abscess still remains doubtful, the only point that should guide us is this—if there is reason to believe that an abscess exists in the brain, the surgeon, on failing to find pus in the temporo-sphenoidal lobe, should not allow the patient to die without exploring the corresponding lobe of the cerebellum.

If the exploring needle used is too fine it may be blocked by brain material before it reaches the mischief, or by the very thick green pus which is characteristic of cerebral abscesses. Broken-down brain detritus might be mistaken for this.

Steps of the Operation of Trephining for Brain Abscess in Connection with Otitis Media.—The tympanum and mastoid cells being rendered as aseptic as possible, the head is shaved, and an anæsthetic cautiously given (p. 165).

A semilunar flap being turned up, and hæmorrhage arrested by applying Spencer Wells' forceps, a $\frac{1}{2}$ -inch trephine is applied over the spot selected (according as the pus is believed to be in the temporo-sphenoidal lobe, or in the cerebellum), and worked cautiously, owing to the thinness of the bone in these regions. The crown removed should not show any of the groove for the lateral sinus, nor, if possible, any middle meningeal branch. If the latter is in the way, crossing the dura mater, it should be secured with two ligatures, or the opening in the bone enlarged. The dura mater being next divided, a little arachnoid fluid may escape, and the brain, which bulges forward, without pulsation, may show lymph upon its surface, and yet the case end successfully if the pus is evacuated. A trocar, or aspirator needle (without making any vacuum) of medium size, is next slowly inserted either straight in, or in a direction downwards, forwards, and inwards towards the apex of the petrous bone. If the abscess is struck, bubbling of foul gas or a few drachms of pus (usually foul) will escape when the needle has entered to a depth of $\frac{1}{2}$ or $\frac{3}{4}$ of an inch. The puncture is then enlarged with a straight bistoury or a Lister's sinus-forceps, and the abscess-cavity syringed out with boracic-acid lotion. A short drainage-tube should be inserted into this cavity, stitched to the flap, and this so arranged as not to interfere with free drainage.* In three cases in which I followed

* Part of these should be cut away, if needful, for this purpose. Prof. Macewen (*Lancet*, 1887, vol. i. p. 616), after finding an abscess by removing a $\frac{1}{2}$ -inch disc 1 inch above and $\frac{1}{2}$ -inch behind the meatus, as there was much oozing of pus, and evidence of a considerable area of softened, pus-infiltrated brain around the abscess, made counter-drainage as follows:—An aperture was drilled just above the bony boundary of the external auditory meatus, involving the squamopetrosal suture. The dura mater was examined here, and found intact. It was penetrated, and the abscess cavity reached. Boracic acid was then passed from this aperture so as to wash out the abscess, and it was continued till it passed

Mr. Barker's directions for temporo-sphenoidal abscess, a little modified for children, I had no difficulty whatever in finding the abscess, but it was by no means equally easy to feel sure that the drainage-tube was properly inserted and retained in the abscess-cavity.

In one case, which ultimately made an excellent recovery, I was unable, thirty-six hours after the trephining (Feb. 20), to satisfy myself that the tube, though still *in situ*, reached the abscess. As there was a great tendency to blocking of the tube, owing to the thickness of the pus and the amount of brain detritus present, it was not stitched, so as to allow of daily removal and cleansing. All did well for a fortnight, save that the temperature tended to remain sub-normal. Then headache returned, and on March 10 I inserted a scalpel along the track of the tube, giving vent to thick, green, sweet pus. A larger drainage-tube was inserted and stiched to the flap, which was partly cut away to facilitate drainage. There was the same tendency for the drainage-tube to get blocked, and a fresh collection again took place, with return of headache. On May 1 I again evacuated from 3 to 4 ounces of pus, operating now through a hernia cerebri, the size of a walnut. This was clipped away with scissors. After this third operation the patient made an excellent recovery. The hernia cerebri was cured by the constant pressure of a leaden plate notched for the drainage-tube. This was kept in place by the unremitting attention of my dresser, Mr. Meadows-Turner.

While soft tubes are safer for the head of a restless patient and more easily secured in position, when there is much tendency for the pus to block the tube, and difficulty of introduction, the use of a silver one would be safer. Mr. Barker (*loc. supra cit.*) says these may be readily fashioned out of an old silver catheter, which, after being made nearly red hot, is perfectly cleansed. The wound is then dusted with iodoform, and sal alembroth gauze or other aseptic dressings applied. Those for the mastoid wound should be kept separate. The drainage tube should be retained as long as any cavity exists, probably for two or three weeks, being shortened very gradually. The treatment should be rigidly aseptic, in order to secure early healing, and to prevent the risk of softening and hernia cerebri.

(iii.) *Thrombosis of Sinuses*.—The following remarks refer to thrombosis of the lateral sinus. This is a grave lesion, from its tendency to cause general pyæmia and distant suppurations. When the mischief is limited to this sinus, as is usually the case in the earlier stages, much hope may be placed in operative interference. Prof. Horsley (*Clin. Soc. Trans.*, vol. xix. p. 290) first suggested ligature of the internal jugular in these cases, and Mr. Lane (*Ibid.*, vol. xxii. p. 262), first adopted this step with success, with the objects of securing more thorough removal of the septic thrombus from the sinus, and to obviate the passage of septic material or antiseptic injections into the circulation. In the *Lancet* (vol. i. 1890, pp. 1057, 1114) is a most instructive paper by Mr. Ballance who has operated in four cases, in two

freely out by the upper opening. The current was then reversed. Drainage-tubes were placed in both apertures. The case did well.

successfully. Where the mischief, in rarer cases, has extended from the lateral to the other sinuses, interference will be hopeless.*

Mr. Ballance (*loc. supra cit.*) believes that the following group of symptoms, when present together, are pathognomonic of septic thrombosis. 1. A history of purulent discharge from the ear for a period of more than a year. 2. The sudden onset of the illness, with headache, vomiting, rigor, and pain in the affected ear. 3. An oscillating temperature. 4. Vomittings, repeated day by day. 5. A second, third, or more rigors. 6. Local œdema and tenderness over the mastoid,† or in the course of the internal jugular.‡ 7. Tenderness on deep pressure at the posterior border of the mastoid and below the external occipital protuberance. 8. Stiffness of the muscles of the back or side of the neck. 9. Optic neuritis (p. 205).

The treatment of these cases must, in Mr. Ballance's words, "be twofold—viz., the free exposure and removal of the focus from which the pyæmic infection has occurred or is threatening; and, secondly, the establishment of a block in the highway, along which the infecting agents are travelling from the local focus into the general circulation."§

This is carried out by first freely opening and clearing out the mastoid cells,|| and then enlarging the opening backwards to the point in Fig. 77. As soon as the groove for the sinus is opened foul pus or gas may escape. The condition of the sinus is investigated, the question of plugging being cleared up by an exploring needle, which, when withdrawn, may smell foully though empty. If a thrombus is present, before the surgeon proceeds further, he should tie the internal jugular vein at the level of the hyoid bone with two chromic gut ligatures and divide the vein between them. If the vessel is thrombosed at this point the ligature should be placed lower down at a point beyond the clot, but the prognosis is here less favourable.¶ The bony outer wall of the lateral sinus having been

* Mr. Sheild (*Diseases of the Ear*, p. 176) gives an instructive case of this kind. Here the eyeballs protruded owing to the thrombosis of the cavernous sinuses. Prof. Macewen, in that storehouse of valuable information (*Pyogenic Diseases of Brain and Spinal Cord*, Figs. 53, 54, 55, pp. 248, 249) figures such a case.

† Absence of these points may be explained by sclerosing ostitis of the mastoid, and in rare instances, Mr. Ballance thinks, by absence of the occipital vein.

‡ Œdema or tenderness over the internal jugular are due to extension of the clotting, and phlebitis, or to enlargement of the deep lymphatic glands.

§ "Whenever the mastoid vein, which perforates $1\frac{1}{4}$ inch behind the meatus, and on a level with it, is found thrombosed, the sinus should be explored" (Pitt, *loc. supra cit.*).

|| The bone should be removed so as to give an opportunity of examining the dura mater over the temporo-sphenoidal lobe in the upper part of the wound, and thus dealing with any sub-dural abscess.

¶ In one of Mr. Ballance's cases, in which the vein was thrombosed, there was some difficulty in identifying it, as it was collapsed and appeared as a small round cord. In a case of Mr. Parkin's (*Lancet*, vol. i. 1893, p. 523) the vein was

thoroughly cut away, the sinus itself is opened with sharp scissors and all offensive clot within reach cleared out by the sharp spoon, curette, or a syringe with a fine nozzle. If, after this is done, blood begins to flow from either end it is *per se* a favourable sign, as it shows that the clotting does not extend far into the collateral vessels. There will be no difficulty in dealing with any hæmorrhage from the lateral sinus provided there be room for dealing with it by means of a sufficient opening in the skull. Firm plugging with strips of iodoform gauze wrung out of carbolic acid (1 in 20) and over this a dressing of aseptic wool and a knotted bandage will arrest any hæmorrhage, however free; as occurred in one of my cases, this hæmorrhage will recur freely during the first few dressings, but without any ultimately untoward result. Constant irrigation with mercury perchloride solution (1 in 4000) should be employed, and iodoform thoroughly used. In one of Mr. Ballance's cases, though the patient's condition was greatly improved by the operation, the evidence of pyæmia (blood-stained expectoration and swelling of some of the joints) persisted. Ten days after the first operation, as pus could be forced out of the opening in the sinus by pressure on the neck, an incision was made down to the vein at the lower border of the parotid gland. The vessel was opened and pus came out, the sinus and vein were then irrigated with perchloride solution, the stream passing in either direction and bringing away offensive clot. The man recovered.

(iv.) *Sub-dural Abscess*.—We owe our knowledge of this condition chiefly to Mr. Barker (*loc. supra cit.*). He believes that two spots are "particularly liable to this condition. The first and commonest, especially in children, is the neighbourhood of the petroso-squamosal suture above. The next and most serious is the sulcus lateralis below." Both varieties are most frequently fatal by setting up a diffuse meningitis. Opening the antrum at a point from $\frac{1}{3}$ to $\frac{1}{2}$ inch behind and the same distance above the centre of the meatus, free removal of the bone with the gouge both in the direction of the petro-squamosal suture and the lateral sinus until the dura mater is well exposed and all question as to the release of septic matter beneath it is set at rest, are the chief points in the treatment of sub-dural abscess (Barker).

(v.) *Meningitis*.—This, when diffuse, will probably always be hopeless. Mr. Barker, in his Hunterian Lectures, which have done so much to aid others in this subject, believes that a plastic localised form of meningitis is not infrequently met with in these cases, especially over the tympanum and squamous bone, or over the sulcus lateralis in the posterior fossa. In such cases as where it is spreading from the roof of the tympanum up over the temporal lobe into the Sylvian fissure, Mr. Barker thinks that

so thickened by periphebitis as to resemble an empty carotid artery. The part excised showed numerous flaky deposits on the intima. The patient recovered, though there was evidence of advanced pyæmia.

free removal of bone with irrigation and drainage would save many a patient. He relates one case (*loc. supra cit.*, p. 68) in which this was very likely the case, but, owing to the patient's happy recovery, this could not be verified.

As to symptoms of meningitis, I fear we have none reliable save involvement of the cranial nerves, and, when we get such evidence as squint, the case has gone beyond interference. The frequency and meaning of optic neuritis has already been alluded to (p. 205). While headache may be as marked a feature in cerebral or cerebellar abscess as in meningitis, I am inclined to think that in the last of these it is more persistent; in the later stages of abscess it is not uncommon for the headache to remit.

OPERATIVE INTERFERENCE IN THE CASE OF FOREIGN BODIES IN THE BRAIN.

Under the above heading such bodies as bullets, knife-points, &c., are included. Depressed and isolated fragments of bone may come within the meaning of foreign bodies, but have already been considered (p. 170).

A. *Bullets*.*—The following questions will suggest themselves when a surgeon is called to a case of bullet wound of the skull:

1. Has the bullet penetrated the skull at all? Thus it may have lodged, rebounded, or fallen out, or

2. It may have passed between the bone and dura mater, without penetrating the latter, and reached a spot quite out of sight. In such cases Sir T. Longmore advises the use of a curved probe and extraction of the bullet "with suitable instruments," if it can be felt. Probably in most hands a second application of the trephine, if needful, at some distance from the wound, so as to extract the bullet here, would be preferable to attempts at removing it from the original wound.

3. Has the ball split into two or more pieces? Balls elongated as well as round are liable to split when impinging on sharp angles of bone. Thus, when the ball splits upon the outer table, part may pass beneath the scalp, while the rest may drive on before it some of the internal table, causing pressure on the dura mater, or even reach the brain.

4. Has the bullet penetrated the brain? If so, where does it lie? Ought any further exploration to be performed, and, if so, ought this to be done through the original wound only or at some counterpoint as well?

Before attempting to answer these last questions, it may be

* Mr. Barwell (*Clin. Soc. Trans.*, vol. xviii. p. 232) makes the following observation, which is of importance if it is found to be constant—viz., that, though the weapon may be held very close, there will be neither scorching nor powder-tattooing, if the bullet be driven by one of the modern fulminates, contained in the same cap with the projectile.

well to deal with that which will be sure to arise first—viz., should the wound be explored or treated expectantly?

The following appears to me to decide in favour of exploring in all cases in which it is clear that the injury is not going to be quickly fatal:

a. The fact that only by exploring will the surgeon be able to answer the question certain to be put to him by the friends whether the brain is injured or no.

b. Whether the bullet has split, whether the internal table is shattered, and, if so, how far it resembles a punctured* fracture, are also points which can alone be cleared up by trephining.

c. Good drainage, disinfection of the wound, are almost hopeless unless this is opened up and explored by trephining if needful.

The following case is not only a good instance of the kind of gunshot injury to the head which may be met with in civil practice, but it shows how slight may be the injury which actually originates the fatal mischief. It was brought before the Clinical Society (vol. xii. p. 5) by Mr. Lucas.

The patient, aged twenty-one, had shot himself with a small revolver. "Almost in the centre of his forehead were two small circular holes, with slightly inverted edges. The surrounding skin was raised into a rounded eminence. There was some bleeding from the nose as well as from the wounds. On turning back flaps, a blackened cavity was opened beneath the skin, formed by the expansion of the powder after it had penetrated the integument. At the bottom of this cavity, a somewhat cruciform aperture was seen in the bone and lying upon the internal table were two flattened bullets. The internal table was driven back so as to give the appearance of a sinus, in which the bullets were lying loose; and at the time we were under the impression that the man had very large frontal sinuses, which had been opened by the bullets. After removing numerous fragments belonging to the external table and diploë, the splintered internal table forming the posterior wall of the cavity was also removed. This came away in large, sharp-edged, angular fragments, two of which were grooved by the longitudinal sinus. When the internal table had been removed, the dura mater was seen at the bottom of the wound, and pulsating. The membrane was entire except at one spot, where there was a small aperture just such as might be made by stabbing the point of a penknife into a sheet of paper. But for that small puncture, it is not improbable that he would have recovered." Septic meningitis came on in about forty-eight hours, followed by death early on the sixth day.

Exploration, with or without trephining, in these cases should be conducted on the lines already laid down (p. 173). The chief differences are only in degree—viz., the greater care with which all fragments should be removed. Occasionally, portions of the bullet are found embedded with very great firmness in the diploë; these are best removed by careful use of gouge or chisel. If the dura mater is found to be injured, every attempt should be made

* Excellent instances of how closely some gunshot fractures may resemble the classical "punctured" fractures, not only in the greater damage to the internal table co-existing with but slight mischief externally, but also in the onset of grave symptoms inevitably fatal unless trephining be performed early, are shown in Figs. 79 to 88, *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. pp. 168, 169

to disinfect this from the first, and so obviate the otherwise inevitably fatal arachnitis. With blunt-pointed scissors, the aperture, if small, should be opened up, and a little iodoform, or equal parts of this and finely powdered boracic acid, dusted within the cavity of the arachnoid; or the parts may be carefully syringed over with a solution of mercury perchloride (1 in 4000), and the above powder dusted on. An adequate-sized drainage-tube should be carried quite up into the skull opening, and retained in position here by strips of gauze carefully packed around. No sutures should be used, as a rule, in these wounds, where swelling of the scalp (it being impossible to render the parts rigidly aseptic) is sure to follow, and is very likely to interfere with the escape of discharges, and where primary union cannot be expected.

If, after exploring, the surgeon is certain that the bullet has penetrated the brain, another question arises as to the wisdom of further exploration and attempts at removal. As a rule, if the bullet is not found within 2 inches of the skull injury, nothing more should be done now, especially if the patient's condition is not good, or the anæsthetic's influence not well maintained. It is needless to say that in exploring the track in the brain the utmost gentleness is essential. As with fine metal probes, owing to the peculiar consistence of the brain, it is very easy to lose the track and thus, at the same time, inflict fresh mischief, it will be wiser to make the gentlest possible use of a bougie (those with a double-silk web are the most suitable) after placing it for a few minutes in a solution of carbolic acid or mercury perchloride. If the bullet is found within 1 or 2 inches of the skull wound, it should be removed with a fine-pointed pair of dressing-forceps. It will be wise, if the track in the brain is much lacerated, to treat it like an abscess, and introduce a soft drainage-tube, to be gradually shortened.

The following points may be adduced for and against the attempt to remove bullets which have lodged in the brain:

The surgeon who decides to abide by the expectant treatment in these cases both immediately after the injury and later on, can justify his course by a sufficient number of cases.* But it must always be remembered that many of these recoveries have been incomplete (*vide infra*), and that in many the patients have had very narrow escapes, and that in others the case has been reported much too soon to be of real value.†

* *E.g.*, Dr. Brunton, *Lancet*, February 12, 1881; Mr. T. Smith, *Lancet*, May 3, 1879; and Otis, *loc. supra cit.*

† In the *Lancet*, August 14, 1886, is the abstract of a case reported to the Society of Surgery, at Paris, by M. Prengueber. The patient had fired a revolver at the middle of his temporal fossa, the bullet lodging in his brain. For the three days following the accident the surgeon abstained from interference, as the only symptoms were general prostration with lowering of the temperature. Epileptiform attacks having occurred on the fourth and fifth day, the wound was exposed and several bony spicula removed, which had penetrated the brain. A stilet

On the other hand, no one, in my opinion, would blame the surgeon who, preferring exploratory to expectant treatment, endeavours to remove the bullet from the brain.

For while the cases of recovery after expectant treatment are few, it is probable that out of these, few as they are, a considerable proportion, if watched, would be found to be incomplete recoveries. Thus, Dr. Otis * writes of balls lodged within the cranial cavity :

“ Many instances were reported of patients who had survived the lodgment of missiles within the skull, but few or none resembling the cases reported by Larrey, of balls encysted in the brain and giving no inconvenience for years. It is, indeed, reported that some patients went to duty with balls lodged in the cerebrum ; but the diagnostic details accompanying the history of these cases are not sufficiently precise to invite the fullest confidence. In most of the cases in which the evidence that the ball remained within the skull was conclusive, either fistulous sinuses existed, or there was much cerebral disorder,† or the position of the missile was discovered after the patient's death at a period remote from the injury.”

The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later, even as long as thirteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain-tissue, or yellow softening is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes. The usual termination is cerebral abscess, this condition having been found in fifty-three cases in which a post-mortem examination was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain symptoms, is that quoted by Wharton from Flourens. This observer found that bullets introduced into different portions of the upper parts of the hemispheres and the cerebellum gradually

having failed to detect the bullet, though passed along its course to a depth of five centimetres, nothing else was done. The epileptiform seizures did not recur, and the patient left the hospital at the end of a month, without any cerebral complication.

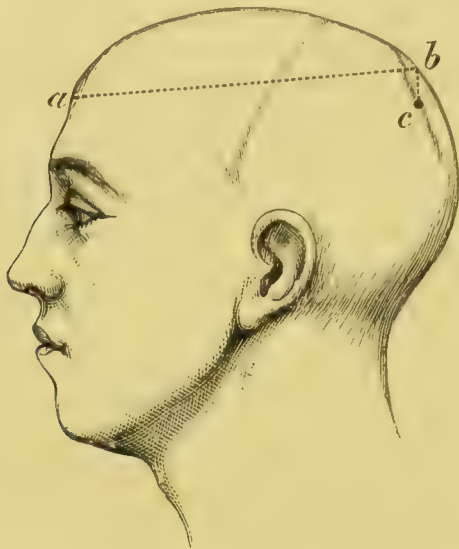
* *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. p. 193.

† Prof. Nancrede (*Intern. Encycl. of Surg.*, vol. v. p. 72) gives the following important abstract of a most careful paper by Dr. Wharton (*Phila. Med. Times*, 1879) in which 316 cases of foreign bodies lodged in the brain are analysed. Of these, 160 recovered, while 156 proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in 106 cases, 72 recovering, while only 34 died. In the remaining 210 no attempt at removal was made, and only 88 recovered, 122 dying. A further analysis shows that, amongst those cases classed as recoveries, death ultimately took place in 10 at periods varying from three to ten years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deteriorated mental powers.

penetrated the brain substance, ultimately reaching the basis cranii, the bullet tracks healing after them (Nancrede from Wharton).

The following is an interesting instance of successful operation for the removal of a bullet penetrating the brain :

FIG. 78.



a, b. Track of bullet and site of the trephine-openings. *c.* Spot where the bullet was found. (Fluhrer.)

The patient,* aged nineteen, shot himself with a pistol held very near to the centre of his forehead. About twelve hours afterwards, when seen by the surgeon, he was semi-conscious, aphasic, with complete loss of motion, without loss of sensation on the right side below the head. Left side hyperæsthetic. Pupils equally dilated. P. 100, T. 101.4°. Ether was given, and under the protection of copious irrigations of corrosive sublimate solution (1 in 1000), the wound of entrance, nearly in the centre of the forehead, was enlarged, including also the wound in the skull. This procedure was complicated by most profuse hæmorrhage from a branch of the anterior cerebral artery, which was finally controlled by small compression-forceps left *in situ*. To this arterial bleeding was added a considerable venous flow from the superior longitudinal sinus, which, like the artery, had been cut across by the bullet. The track of the ball through the brain was then examined by a straight Nélaton's probe,† and the point on the

* This case was under the care of Dr. Fluhrer (*New York Med. Journ.*, March 28, 1885).

† Dr. Fluhrer considers that a probe for these cases should supply the following conditions. The end should be large, so as not to wound the brain and make a false passage, and also, when beneath the surface, be easily discoverable by palpation or dissection. It must be sufficiently rigid to retain a given shape, and sufficiently bulky to supply a large surface to the fingers. Finally, it should be as light as possible, that delicacy of touch be not lessened, and that no vibrations be lost instead of being communicated to the fingers. It should be made of tempered aluminium. If it is necessary to curve it near the exploring end (which increases the errors in interpreting the position of the extremity), the other end of the shaft should be bent, in the same plane, in the opposite direction.

scalp noted at which the probe would emerge if projected through the head. At this point the cranium was exposed and trephined. The trephine-hole was enlarged towards the assumed opening of emergence of the bullet, and the dura mater slit in the same direction. Some effused blood and disintegrated brain matter appearing, more of the skull was cut away, and the slit in the dura mater prolonged, until a gush of brain matter, and a rent in the pia mater, demonstrated the point of impact of the bullet. The probe was introduced through the opening in the pia, and passed downwards towards a point where a feeling of resistance had previously been felt with the tip of a finger introduced through the second opening. At the distance of an inch the bullet was detected, and then extracted with slender-bladed forceps. It weighed 42 grains. One end of a small rubber drainage-tube was secured to one end of the probe; this was again passed through the brain from before backwards. The tube, as it was drawn through the wound, became filled with brain-detritus and blood. The after-history was one of gradual but progressive amendment. On the sixth day the drainage-tube was withdrawn, and replaced by a drain made of four strands of catgut and ten of horsehair, this being passed by tying it on to the anterior end of the drainage-tube. As the tube was withdrawn the drain occupied its place. It was removed, strand by strand, on different days. On the eighth day the compression-forceps was found to be loose. A hernia cerebri developed at both cranial openings. The herniæ being subjected to a slight continuous pressure gradually disappeared. Eleven weeks after the operation, both wounds had healed. The operation was completed in about four hours, the greater part of the time having been spent in stopping the cerebral hæmorrhage. After leaving the hospital, the patient returned to work, a slight impairment of memory being the only apparent consequence of his wound. A severe blow accidentally made upon the anterior scar some months after returning to work, determined a violent convulsive attack, which recurred at the end of three weeks. Bromides were freely given, and no further recurrence had taken place when the report was made six months later.

The case will amply repay careful perusal. It is a splendid instance of what surgical skill and sagacity can effect.

B. Other foreign bodies besides bullets which may penetrate the brain are knife-points. These, with their tendency to form cerebral abscess, have already been alluded to (p. 171).

C. Another class of body which may be met with by the surgeon in civil practice is shown in the following case of Mr. Couper's*.

A house-painter fell twelve feet from a ladder, impaling the right side of his skull on the spike of an iron palisade. When brought into the hospital there was a clean cut wound three-quarters of an inch long, immediately under the right ear, partly overlapped by its lobule. In this the end of a large rough piece of metal, corresponding to a freshly broken spike, could be felt, and its direction could be inferred to be upwards, inwards and a little forwards from the outer wound, which was situated half an inch under the external meatus between the mastoid process and the ramus of the jaw. There was some bleeding from the right ear, but no facial or other paralysis. The patient being under chloroform, Mr Couper succeeded, after much forcible wrenching, in extracting the iron, the head being as far as possible steadied by three students and the operator's hand. During these efforts 3 or 4 ounces of blood oozed from the wound; this hæmorrhage ceased as soon as the iron was out, but a small quantity of semi-fluid brain substance flowed. Right facial paralysis came on two days after the injury, then

* *Lond. Hosp. Reports*, vol. ii. *Hutchinson's Clin. Surg.*, vol. i. p. 91, pl. xvii.

delirium, restlessness, and on the seventh day left hemiplegia, followed by convulsive attacks, affecting the right limbs and right half of the face. Two days later, or nine days after the accident, the patient died.

Autopsy.—No pus between dura mater and bone; dura mater healthy, save for congestion. On opening it, the surface of the right hemisphere showed well-marked sub-arachnoid meningitis. The posterior part of the right middle cerebral lobe had been deeply wounded: the brain substance, at this spot softened, and streaked with pus, was healthy everywhere else. The spike had entered just under the apex of the mastoid process, traversed the internal ear, and driven several irregular masses of petrous bone through the dura mater.

Probably, in a similar case, the careful use of chisel or gouge would loosen the foreign body, while the opening up of the wound would facilitate drainage, and cleansing the parts damaged, including the brain itself.

TREPHINING FRONTAL SINUSES.

Prof. Ogston (*Med. Chron.*, vol. i. No. 3, p. 1) has advised the use of the trephine in cases of retention of secretion and chronic inflammation of the lining membrane of these sinuses.

Indications.—Uneasiness, pain over forehead and tenderness on firm pressure, with occasional escape from the nose of thick pus, the appearance of which is not to be otherwise accounted for.

The above are due to retention analogous to that causing empyema of the antrum. As no probe can be passed from below, when all other treatment fails, the sinuses should be opened above, and their communication with the nose dilated.

Operation.—A single vertical incision is made down to the bone, commencing at the root of the nose, and extending upwards for an inch and a half over the nasal eminence of the frontal bone. The periosteum having been divided and carefully cleared back, a trephine, the size of a sixpence, is applied in the middle line.

When the trephine has been found to enter a cavity which the point of a quill or a probe shows to lie rather at the lower part of the crown, the disc is removed. If the sinuses are large, this is readily effected, but if they are small, the disc must be removed piecemeal, with a mallet and chisel, until the sinuses are laid bare. The bleeding is slight.

The object which now meets the eye is the livid mucous membrane lining the sinuses. On opening it, it is found thickened, and to contain mucus or muco-pus. This being sponged away, and the orifice in the nose found* with a probe or a fine gum-elastic catheter, a drainage-tube, about the size of a crow-quill, should be slid down into the nose, and its upper end left in the sinus, the skin being united over it, to secure union by first intention.†

If, however, owing to great thickening of the mucous mem-

* If the opening be too small, Prof. Ogston advises that it should be enlarged by thrusting down a trocar or stout director.

† In one of Prof. Ogston's cases a small fistula persisted for some time.

brane, foul caseous pus, &c., it is necessary to use the sharp spoon, and to disinfect the recesses of the sinuses by syringing out, insufflation with aseptic powder, or brushing over with zinc chloride or silver nitrate solutions, it will be wiser to run the risk of more tedious closure of the opening, and to bring the upper end of the drainage-tube out on to the forehead, only partly closing the wound around.

In 1894 I had occasion to trephine the left frontal sinus in the following case :

The patient, a hospital nurse, had persistent frontal headache, with tenderness, after influenza. The left sinus having been exposed by the steps given above, the mucous membrane was found to be purplish in colour, much swollen, and bleeding freely. The communication between the sinuses and the nose, which appeared to be closed, having been opened up with sinus-forceps, to diminish the risk of scarring, I replaced the crown of bone, notching this for the exit of a small drainage tube. I had reason to regret that I had not drained through the nose, as a sinus persisted, necessitating removal of the crown of bone which had necrosed. A drainage-tube having been brought out through the wound and by the nose, the former rapidly healed.

It is probable that analogous operations would be found useful in very obstinate cases of ozæna, in which there is evidence of the mischief having extended to the frontal sinuses, and in which, therefore, other treatment, including Rouge's operation (p. 295), will be insufficient.

Every attention should be paid to keeping the wound as aseptic as possible, and to preventing erysipelas. A dressing of iodoform gauze strips wrung out of carbolic-acid lotion, and over this one of boracic-acid lint, wrung out of a saturated solution of boracic acid, iced if needful, frequently renewed, or kept wetted, will be found efficient.

CHAPTER III.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS.

OPERATIONS ON THE BRAIN.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS (Figs. 79 to 83).

Motor Area.—The motor area, or that part of the cortex in which lesions cause paralysis on the opposite side of the body, lies beneath the anterior half of the parietal bone. It may be said to be in form a parallelogram, about an inch wide, with its centre traversed obliquely by the fissure of Rolando.

Speaking succinctly, but perhaps with sufficient accuracy for practical purposes, the centre of speech lies (on the left side) at the lower and anterior angle, or a little below and in front of the area. Paralysis or convulsions limited to one lower extremity need the trephine at the upper end of the opposite motor area. paralysis of the arm at the middle third, paralysis of the face at the lower third. Three applications of a trephine with chipping away of bone will expose it for thorough examination; if the paralysis is distinct and limited, one or two applications will probably suffice to find the lesion. Where lesions are combined (foot-note, p. 226), points intermediate between the respective centres must be exposed.

The following aids in finding the above most important fissure will be found useful:

i. The upper end of the fissure is found about $\frac{1}{2}$ inch behind a point midway between the root of the nose and the external occipital protuberance; the lower end is about 1 inch behind the bifurcation of the Sylvian fissure. This bifurcation corresponds to a point 2 inches behind and $\frac{1}{4}$ inch above the level of the external angular process of the frontal bone.

ii. Mr. Godlee, in a most interesting case (p. 228) of trephining for cerebral tumour, used the following simple method of exposing the fissure of Rolando in its middle third:

(1) A line was drawn between the frontal and occipital protuberances.

guidée par les Localisations cérébrales, Paris, 1878) directions for finding the fissure of Rolando. The upper end is situated 2·2 inches behind the bregma or junction of coronal and sagittal sutures. The position of the lower end is thus determined. From the very end of the external orbital process, where this rises up to join the temporal crest, draw a horizontal line of 2¼ inches, and from the extreme end of this draw a vertical line of a little over 1 inch. Between these two points, passing rather obliquely forwards, lies this fissure.

FIG. 80.

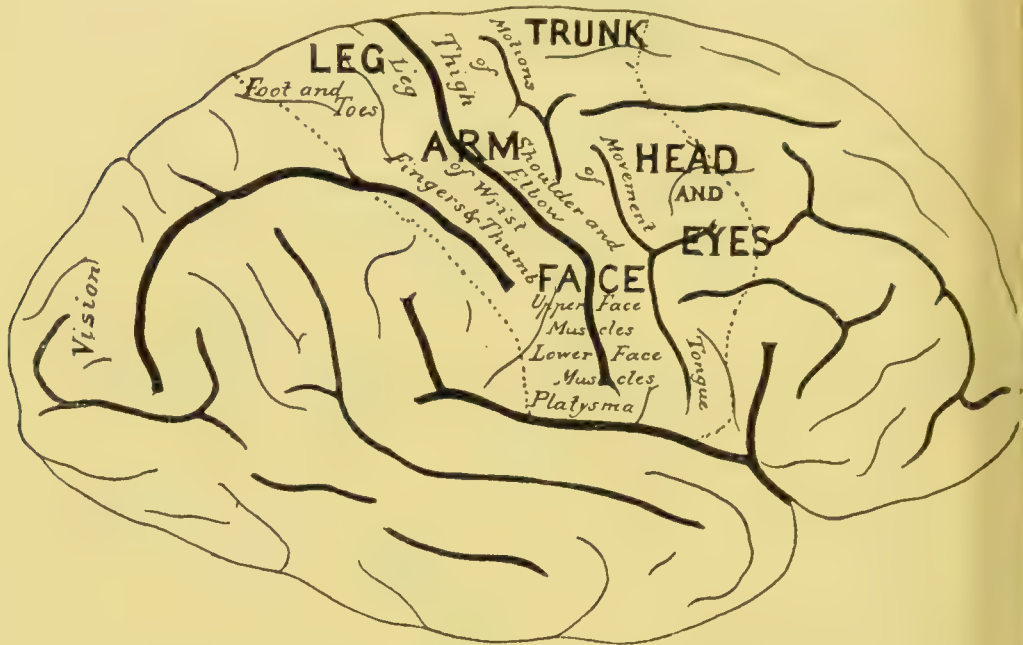


Diagram (after Eberstaller) of the fissures, convolutions, and the functional areas with their extent on the right hemisphere of the brain. (Starr.)

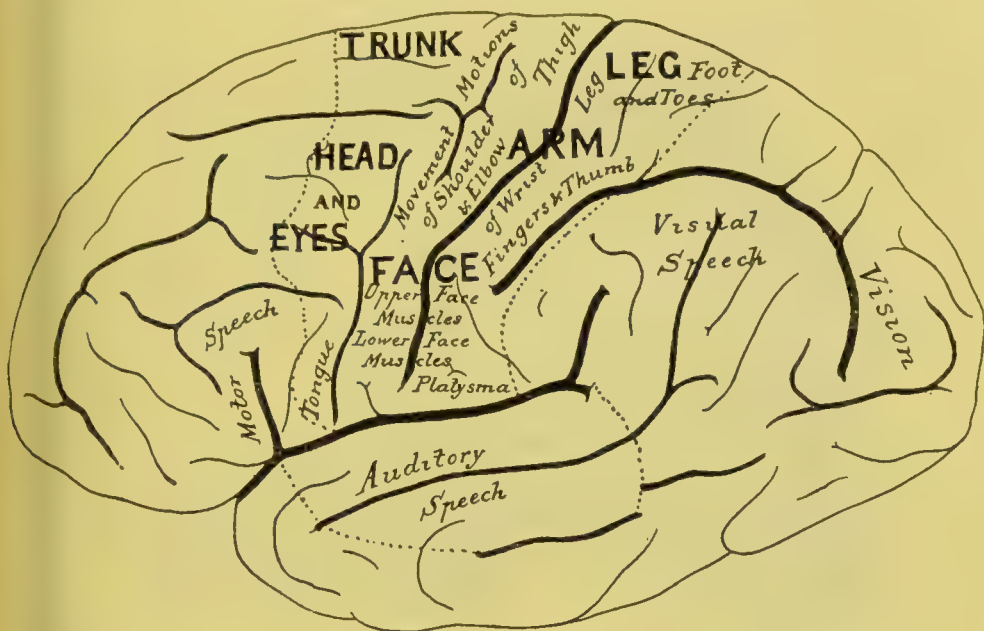
With regard to the directions already given and those to follow, it must be remembered that the eminences and sutures of the skull, and the relations of the sulci and convolutions beneath to the cranial surface, are liable to variations.* I believe that the points here given will be found easily defined, and occupying a central position with regard to the brain beneath and its possible variations. The surgeon must be prepared to use his trephine freely.

Position of the Chief Sutures (Figs. 79 to 83).—After considering that most important part of the brain, the motor area, which lies under the parietal bone, it will be well to recall the landmarks of the chief sutures which are met with in that region. The *coronal suture*, the anterior limit of the parietal bone, may thus be traced. The point where it leaves the sagittal suture, the

* See papers by Prof. Turner, *Journ. of Anat. and Phys.*, vol. xviii.; Mr. Hare, vol. viii.; and Messrs. Anderson and Makins, *loc. supra cit.*

bregma, may be found by drawing a line from a point just in front of the external auditory meatus straight upwards on to the vertex; from this point the coronal suture runs downwards and forwards, speaking roughly, to the middle of the zygomatic arch, or, more exactly, to join the temporal part of the great wing of the sphenoid, which it meets an inch and a half above the zygoma, and not quite an inch behind the external angular process of the frontal bone.

FIG. 81.



A diagram, similar to that shown in Fig. 80, of the left hemisphere (Starr.)

Under this suture lie the posterior extremity of the three frontal convolutions (Fig. 82), for the frontal lobe lies not only under the frontal bone, but extends backwards under the anterior part of the parietal, the fissure of Rolando, which forms the posterior boundary of the frontal lobe, lying from $1\frac{1}{2}$ to 2 inches behind the coronal suture.

The *occipito-parietal* or *lambdoidal suture*, the posterior limit of the parietal bone, will be marked out by a line which starts from a point $2\frac{3}{4}$ inches above the external occipital protuberance, and runs forwards and downwards to its termination, which will be found on a level with the zygoma, $1\frac{1}{4}$ inch behind the meatus.

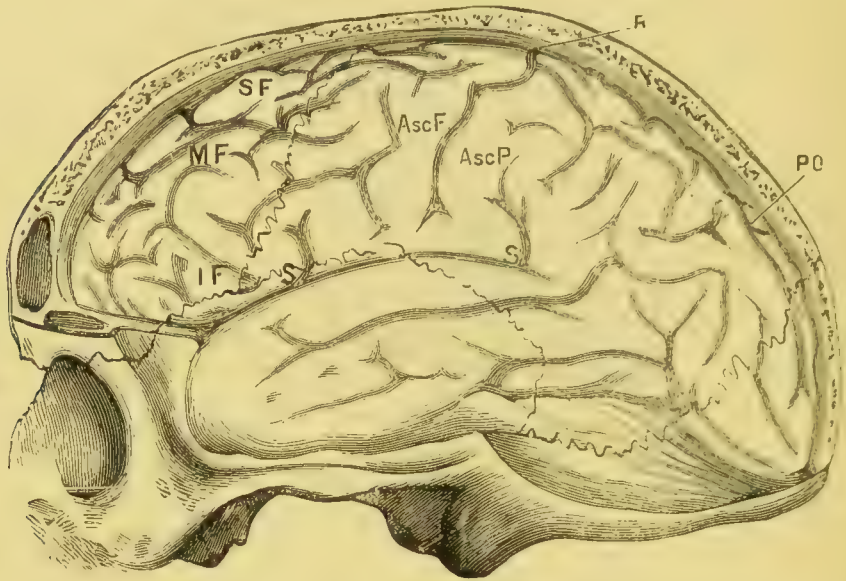
As the occipital lobe is not limited to the upper portion of the occipital bone, but extends forwards under cover of the posterior part of the parietal, the parieto-occipital fissure lies about $\frac{3}{4}$ inch in front of the apex of the lambdoid suture (Fig. 82). But this varies a good deal according to the ossification of the squamous part of the occipital.

The *squamous* or *squamoso-parietal suture* is not so easy to mark

out, owing to the irregularity of its curve and variations. Its highest point is usually $1\frac{3}{4}$ inch above the zygoma (Fig. 82).

The Sylvian fissure,* which separates the temporo-sphenoidal from the parietal lobe, passes from below obliquely upwards and backwards across the line of this suture near its middle (Fig. 82), the temporo-sphenoidal lobe not only lying under the squamous and great wing of the sphenoid, but passing upwards under cover of the lower part of the parietal. In Prof. Turner's words, this fissure commences immediately behind the posterior border of

FIG. 82.



The above view of the brain *in situ* shows the relations of the surface convolutions to the regions of the skull. R, Fissure of Rolando, separating the parietal from the frontal lobe. PO, Parieto-occipital fissure, separating the parietal and occipital lobes. S, S, Fissure of Sylvius, separating the temporo-sphenoidal from the frontal and parietal lobes. SF, MF, IF, The superior, middle, and inferior frontal convolutions. Asc.F., Ascending frontal convolution. Asc.P., Ascending parietal convolution. The outlines of the coronal, squamoso-parietal, and lambdoidal sutures are also shown. (After Turner.)

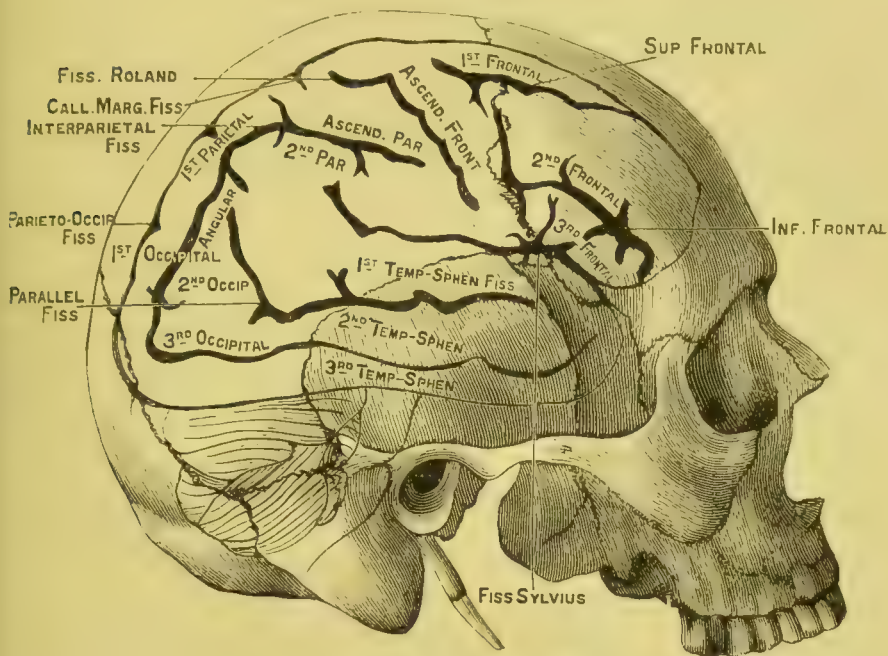
the lesser wing, and in its course backwards and upwards is covered by the great wing of the sphenoid where it articulates with the anterior inferior angle of the parietal. It then passes obliquely under cover of the anterior superior part of the squamous bone, and appears in the lower part of the antero-parietal region.

* The fissure of Sylvius (Figs. 79, 82) is found by drawing a line from a point $1\frac{1}{4}$ inch behind the external angular process of the frontal bone to a point $\frac{3}{4}$ inch below the most prominent part of the parietal eminence. Measuring from before backwards, the first $\frac{3}{4}$ inch of this line will represent the main fissure, and the rest its horizontal limb. The ascending limb will start 2 inches behind and slightly above the external angular process, and runs vertically upwards for about an inch.

The following practical points are given by Prof. Nancréde :

(1) Monoplegia or spasms limited to one member, or a portion of one member, indicate limited lesions. If the lower limb be affected, the upper portion of the ascending parietal (Figs. 79 to 83), with perhaps also the corresponding part of the ascending frontal, is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

FIG. 83.



The chief convolutions and fissures on the outer surface of the brain, together with the outlines of the sutures and bones beneath which they lie. Diagrammatic. (After Roberts, of Philadelphia.)

(2) With paralysis of the arm and leg, the lesion probably involves the upper two thirds of the ascending convolutions, with the paracentral lobule. The trephine should then be placed at the upper part of the line, a little lower than in the former case. It may perhaps be necessary to enlarge the opening by cutting out a circle lower down.

(3) Paralysis of the upper extremity alone probably indicates injury to the middle third of the ascending frontal convolution, and the trephine should be applied a little in front of the middle third of the fissure of Rolando.

(4) Paralysis of the lower part of the face points to a lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal.

(5) In simple aphasia the trephine-crown should be placed lower down still, in front of and below the lower extremity of the left fissure of Rolando.

(6) In most cases many centres are affected,* and consequently the surface to be exposed is much larger. Thus :

With paralysis of both lower extremities, the summit of the line and the contiguous superior portion of the cranium must be removed. With paralysis of one upper and one lower extremity (hemiplegia), the operation must be performed at the middle and upper portion of the line ; in paralysis of the arm with facial palsy, at the inferior third of the line, and a little in front ; in palsy of the upper extremity with aphasia, the opening should be made below and in front of the line ; with facial paralysis and aphasia, the bone should be removed well in front of the left line, and below its inferior extremities (*Intern. Encycl. Surg.*, vol. v. p. 90).

The above statements from Prof. Nancrede, following M. Lucas-Championnière, are liable to revision with advancing knowledge.

Contra-indications to Trephining in Lesions of the above Cerebral Centre.—Any evidence of lesions of the base, *e.g.*, paralysis of one or more cranial nerves, or Cheyne-Stokes' respiration. Also hemiplegia, accompanied by marked anæsthesia, contra-indicates operation, as the latter symptom points to lesions which implicate other portions of the encephalon than the motor area, and which are too deeply seated to be accessible to operative interference.

PRACTICAL VALUE OF CEREBRAL LOCALISATION.

I propose to give instances of this under the following headings :—(A) In head injuries ; (B) In brain growths.

(A) **Cerebral Localisation in the Diagnosis and Treatment of Injuries to the Head.**—A typical case, in which localisation may help the surgeon in trephining, would be one in which the injury is limited to the cranium, and is followed immediately by paralysis. Secondary or tardy paralysis may be the result of later inflammatory processes.

M. Lucas-Championnière (*La Trépanation guidée par les Localisations cérébrales*, p. 107) gives this interesting case :

A man was found in the street with slight paralysis of the right arm, but sensibility perfect. There was a small superficial cut, $\frac{1}{2}$ inch long, over the left parietal eminence. Five or six days later the patient became stupid and unable to swallow, and convulsions† increasing in violence, and involving all the body, save the right forearm and hand, set in. Suspecting a fracture of the inner table, M. Lucas-Championnière trephined at the site of the wound, and found a fine fissure just in front of this ; there was a slight depression of the fragments which were wedged tightly together. After the operation the convulsions ceased, and

* The following combinations are those usually met with (Nancrede, *loc. supra cit.*, p. 89) : Paralysis of face and aphasia ; aphasia and paralysis of the arm ; paralysis of arm and face ; paralysis of the upper and lower extremities.

† Convulsions in themselves are only an indication for interference when they are localised and persist, and especially if they alternate with paralysis of the same muscles.

a good recovery took place, with use of the right arm. The fracture was proved by measurements to be over the middle and lower part of the fissure of Rolando, considerably in front of the scalp wound.

The following case of cerebral lesion (Intra-cranial Sub-dural Effusion of blood) diagnosed from motor symptoms alone was given by Prof. Macewen in his most striking address at the Glasgow meeting of the British Medical Association (*Brit. Med. Journ.*, Aug. 11, 1888):

A boy had, consecutive to a fall six days before, convulsions beginning in the left side of the face, gradually involving the left arm and subsequently the left leg, consciousness being preserved. Paresis of these parts remained, though sensation was unimpaired. The parts were always affected in the same general order, and the convulsions, persisting, finally became general, with loss of consciousness. These motor phenomena indicated a lesion on the right side of the brain, pronounced at the middle and lower part of the ascending convolutions, as the face and arm centres were the first to show evidence of stimulation. The lesion was evidently of an irritative kind, such as might be caused by a bone-spiculum driven into the brain, or by pressure on its surface. It was clearly not destructive, *e.g.*, a severe cerebral contusion. It was resolved to expose the lower part of the fissure of Rolando. The head being shaved, a scarcely perceptible irregularity was detected near the coronal suture. Trephining was performed at a point slightly behind the auriculo-bregmatic line, and midway between the auditory meatus and the vertex. This happened to correspond to the posterior extremity of a fissure which ran across the coronal suture. There was no extra-meningeal hæmorrhage, but the dura was very dark. On opening this, 2 ounces of clotted blood escaped from the sub-dural cavity. There was no recurrence of the fits, and the patient survives in perfect health.

Case* of Traumatic Aphasia successfully treated by removing Blood-clot from the interior of the Cerebrum—

The patient had been struck on his head with a penknife six days before admission. At that time he had difficulty in speaking correctly, which had increased somewhat, and pain in the left side of the head, but no paralysis or loss of sensation. A small scar was found over the left squamous bone, 2 inches from the external angle of the orbit, and $\frac{3}{4}$ inch above the zygoma. Both forms of aphasia (motor, speaking; and sensory, word-blindness) were to a certain extent present. Five days later the scar was explored, and a wound of the squamous bone, in size and shape likely to have been produced by a small penknife, found, and cut out in a trephine-circle. The knife had penetrated the dura and brain, the large posterior branch of the middle meningeal just escaping. The dura being opened, a sinus-forceps was gently passed along the brain wound, and, on separating the blades, a blood-clot presented, and was gradually extruded by brain-pressure. Some more was removed by the forceps and by a stream of weak mercury-perchloride solution. A drainage-tube was inserted. On the evening of the same day the aphasia was much improved. Next morning the patient was again more aphasic, and it was found that the tube had become blocked. On freeing it, much fluid with broken-down clot escaped, and the power of speech improved. The patient recovered uninterruptedly, regaining completely his power of writing, reading, and speaking. Dr. Ball believed that the knife had penetrated the superior temporo-sphenoidal gyrus, traversed the Sylvian fissure, and probably injured Broca's convolution.

(B) Cerebral Localisation in the Diagnosis and Removal of

* Dr. C. B. Ball, *Trans. Roy. Acad. of Med. Ireland*, vol. vi. p. 155.

Cerebral Tumours.—Amongst the cases which have been published there have been none to surpass in helpfulness, from the completeness of the details and the accuracy of its reasoning, one of the earliest of the cases submitted to modern surgery—viz., that trephined by Mr. Godlee for Dr. Hughes Bennett, in 1884 (*Med.-Chir. Trans.*, vol. lxxviii. p. 244), an abstract of which is given below :

A man, aged twenty-five, had, four years before, suffered from slight concussion from a blow on the left side of the head. A year later first set in twitchings in the left side of the mouth and tongue, paroxysmal and irregular in occurrence. Some months later fits began, with loss of consciousness and general convulsions. This condition lasted two and a half years ; and six months before admission, twitchings of the left hand, followed shortly by weakness of the left fingers, hand, and forearm, were noticed. For three months these had prevented his using his tools. During this last period there had been twitchings of the left leg, which had also been getting weak. There was nothing abnormal in the skull or scalp. Vision was normal, but optic neuritis was present on both sides, most marked on the right. Hearing was less acute in the right. There was now complete paralysis of the left fingers, thumb, and hand, the elbow movements were very limited, those of the shoulder impaired. There was no rigidity or wasting of muscles. The toes of the left leg did not clear the ground in walking. There was persistent vomiting and retching, with attacks of lancinating headache, rendering life intolerable. Large doses of the iodides were fruitless.

An operation being decided on, the motor area and the diagonal line representing the fissure of Rolando was mapped out by the proceedings already given at p. 220. Theoretically, in order to hit the middle of the fissure of Rolando, the centre of the trephine should have been placed about $\frac{1}{2}$ inch behind the diagonal line, and about $1\frac{1}{2}$ inch from the median longitudinal line. As, however, there was a tender spot on the scalp 2 inches anterior to this, the first opening was made (with a trephine 1 inch in diameter) between the two.* The dura mater was normal ; after a crucial incision was made in it, the brain was thought to bulge abnormally, and to be rather more yellow than usual, otherwise it was healthy. A second crown was cut away, overlapping the first, external to and slightly in front of it, and the angles of bone rounded off with a chisel and hammer, the brain being protected with a copper spatula. These two openings were then joined by one posterior to them, and, the edges being chipped away, a triangular aperture was left measuring 2 by $1\frac{3}{4}$ inches. The dura mater was opened, and a surface of brain exposed nearly equal in size to that of the skull-opening. Occupying most of this space, and crossing it obliquely from above and behind, downwards and forwards, was a convolution. Into the centre of this convolution an incision about $\frac{3}{4}$ inch in length was made with a scalpel. From $\frac{1}{2}$ to $\frac{1}{4}$ inch below the surface lay a transparent, lobulated, solid tumour, thinly encapsuled, but quite isolated from the surrounding brain substance. The incision into the cortex being prolonged, the sides of the growth were easily separated by a spatula of steel, readily bent into any shape. The superficial surface of the growth being thus isolated, this portion was removed with the finger ; as part now broke away, the deeper parts were enucleated with a sharp spoon, the scraping being continued till apparently only healthy brain-matter remained. This caused rapid swelling up of blood into the cavity, which would have held a pigeon's egg. Sponge-pressure failing, the hæmorrhage was finally arrested with the electro-cautery. The dura mater was drawn together with sutures, and a drainage-tube

* The centre of the opening was $1\frac{1}{4}$ inch from the middle line and $\frac{1}{2}$ inch behind a line drawn vertically upwards from the meatus of the ear.

inserted beneath it. Elsewhere the skin was brought accurately together. Antiseptic precautions, including the spray, were used throughout. The anæsthetic, chloroform, was taken well.

The wound was not dressed till the third day, when the discharge had a distinctly putrefactive smell: the scalp near the wound was somewhat œdematous. The next day wet boracic-acid dressings were applied, there was hardly any trace of smell, but a hernia cerebri as large as half an orange was protruding through the lips of the wound. There were no twitchings of limbs or face, no headache. The patient was bright and cheerful, with good appetite. The hernia cerebri, however, increased, and on the eighth day, having reached the size of half a cricket-ball, was snipped away with scissors, the parts removed consisting chiefly of granular matter and clot, with, apparently, little true cerebral stricture. The cut surface was treated with a strong solution of zinc chloride and iodoform, and a cap of block-tin applied. The hernia cerebri again increased somewhat, but all seemed to be doing well, when, on the twenty-first day, a rigor appeared, headache followed and vomiting, then restlessness, sleeplessness, and gradual sinking about four weeks after the operation.

At the autopsy extensive arachnitis was found. The parietal area appeared to have fallen in; in its centre, and occupying the position of the fissure of Rolando, was the wound in the brain. The destruction of the cerebral cortex involved nearly all the ascending parietal convolution, the upper part of the ascending frontal, and the anterior third of the supra-marginal gyrus. The extent of softening was not great, but it was difficult to tell this accurately, as the brain had undergone the process of hardening. The growth was a glioma, of the size of a walnut.

In commenting on the case, most interesting remarks are grouped under the following heads: (1) Diagnosis. (2) Surgical treatment. (3) Clinical phenomena after the operation. (4) Revelation of the autopsy physiologically and pathologically considered.

These will well repay most careful perusal; only the chief points can be given here.

(1) *Diagnosis*.—A brain growth on the right side was diagnosed in this case on the following grounds:—Slow progress, uncontrollable vomiting. Violent pains. Double optic neuritis. It was thought to occupy the cortex because certain motor tracts were implicated in definite order, because paralysis was present without loss of sensibility, and above all because of certain paroxysmal seizures of local convulsions occurring without loss of consciousness, eminently suggestive of irritation of the grey matter.

In this case there was complete paralysis of the fingers and hand, with inability to pronate and supinate the forearm, there was partial paresis of the movements of the elbow, and weakness of those of the shoulder-joint. There was also slight paresis of the leg and one side of the face. Accompanying all these there were paroxysmal convulsions in all these regions, occurring either singly or in definite order one after the other. These phenomena were to be accounted for by an extensive but not absolutely complete destruction of the motor centres of the fingers, hand, and forearm, with slight encroachment on and irritation of those of the face, upper arm, and leg. A very definite localisation was thus permitted, and the tumour was pronounced to have occupied

the whole thickness of the middle two-fourths of the ascending parietal convolution, and a portion of the adjoining upper half of the ascending frontal convolution.

The growth was proved to be limited by the fact that the centres of the leg above, of the face and tongue below, of sight behind, and of the movement of the eyeballs in front, were not seriously involved. It could not have exceeded 2 inches in diameter, and proved to be a glioma, of about the size of a walnut, lying obliquely in the fissure of Rolando. As to the probable nature of the tumour, the age of the patient, the absence of syphilis, and the slow progress, suggested glioma.

(2) *The Operation.*—In this the advantages of the chisel and hammer over Hey's saw were exemplified. Mr. Godlee considers that the use of a larger trephine might be advisable in similar cases. One convolution only being exposed during the operation, there was at the time some question as to whether it was the ascending frontal or parietal. This doubt arose from the circumstance that in the attempt to approach the tender spot the theoretical position had been slightly departed from. After death, however, it was apparent that the convolution which had been incised was that in which from the first the disease had been diagnosed to exist—viz., the ascending parietal. There was no external appearance of disease about this part except that it seemed swollen, less glossy, and less vascular than natural. An incision into this showed the morbid growth to be immediately under the surface, and almost completely involving the entire thickness of the cortex. In clearing away the superficial parts of the growth a small spatula, neither sharp nor blunt, and so tempered that it would keep any shape given to it was found most serviceable. It may be questioned whether it was advisable to arrest the hæmorrhage from the interior of the wound by means of the galvano-cautery, as the bleeding was not severe and would no doubt have become arrested by natural means. The use of this instrument appears to have brought about the putrefaction which was the cause of the inflammation and consequent hernia cerebri. It may be doubted if the putrefaction was ever completely subdued: the fact of the meningitis occurring at last, and that of smell having again become apparent after the attempt at removal of the second protrusion, point probably to a continued septic infection. As to the hernia cerebri, it was remarkable in the first place that the discharge continued for so long to be so copious and so watery as to suggest the idea of its being cerebro-spinal fluid.* Secondly, there was a difficulty in shaving it off owing to the enormous size of its base and the danger of serious hæmorrhage.

* Whether the lateral ventricle had been opened into, the post-mortem examination did not prove conclusively. There was no collection of foreign matter in its interior; at the same time the softening had extended close to it.

(3) *Clinical Phenomena following the Operation.*—The patient lost his headache, vomitings, and violent twitchings in the limbs; even the double optic neuritis markedly diminished. The only change which followed the operation was completion of the paresis of the upper extremity, evidently due to the unavoidable destruction of the remaining arm-centres in the removal of the tumour. Coincident also with the formation of the hernia cerebri came fresh symptoms, in the shape of paresis of the left leg and partial anaesthesia of one-half of the body. These were probably due to the effects of simple pressure, and possibly to the subsequent secondary softening of the conducting fibres caused by it.

(4) *Revelations of the Autopsy.*—The brain was practically everywhere healthy except over the area injured by the operation and in the membranes in the immediate neighbourhood. The meningitis was due to irritating matter from the interior of the wound flowing downwards between the layers of the arachnoid, and accumulating at the base of the brain. The local inflammation of the wound had opened out the parts, and separated the adhesions so as to allow the discharge to percolate into the cranial cavity, but not till three weeks after the operation.

The following case, though not in the motor area,* is of great interest from the size of the growth, its less usual site, and the complication of hæmorrhage, eventually fatal:

The patient was affected with cerebral symptoms extending over eighteen months, consisting of left hemianopsia, which could only be accounted for by a destructive lesion in the neighbourhood of the gyrus cuneatus of the right occipital lobe, and locomotor disturbances, which appeared to be due to the pressure effects of a tumour on structures below the tentorium, and implied a growth of considerable size. Operation having been decided upon, a U-shaped flap was raised, and a 1-inch trephine applied at 1 inch above the occipital protuberance, and the same distance from the middle line, beyond the limits of both the longitudinal and lateral sinuses, and the bone removed until an oval opening $2\frac{3}{4}$ by $2\frac{1}{2}$ inches was made, exposing a dura mater of a deeper hue than normal; section of this exposed the tumour, the outlying edges and base of which could not be reached in spite of further removal of the cranium, it was therefore incised and some of its softened, granular and fatty-looking contents forced out. Its size was now somewhat diminished, and the forefinger could be passed between the cranium and tumour, and by its aid the delicate cellular attachments that held the mass in place were felt to yield easily, enucleation now became possible, and the base was finally reached. By next drawing the finger gently but firmly towards the cranial opening, the tumour was torn nearly completely in two, and its outer half lifted out; then the inner part was separated from the falx with the help of the finger-nail and withdrawn. Inspection of the mass showed that the tumour had been entirely removed, and that its probable attachment had been towards the posterior border of the falx; the tumour was a spindle-celled sarcoma, weighing $5\frac{1}{2}$ ounces, measuring $3\frac{1}{4}$ inches long by $2\frac{1}{2}$ inches wide, and being $8\frac{1}{2}$ inches at its greater circumference. The falx was crowded over towards the left, and the tentorium depressed; two bleeding points were

* "Removal of a Large Sarcoma, causing Hemianopsia, from the Occipital Lobe of the Brain," by Dr. Birdsall and Dr. Weir: *New York Med. News*, April 16, 1887; *Annals of Surgery*, vol. vi. No. 2, p. 149.

observed, one being in the region of the straight sinus, although not free enough for that vein, and probably belonging to the pedicle of the growth, while the other was apparently arterial. It being found that the hæmorrhage could be checked by direct pressure, the cavity was packed with 5 per cent. iodoform gauze, not too tightly, as it was assumed that the released brain would contribute additional pressure, and the ends of the strips were allowed, for easy extraction, to protrude from the lower angle of the scalp wound; the dura was partly united over the gauze by several loose sutures instead of being brought closely together, and the scalp wound closed with catgut sutures, a rubber drainage-tube being introduced under the skin up to the skull opening, and over these sublimated and iodoform peat bags were secured with gauze bandages. The patient soon showed symptoms of hæmorrhage which could not be controlled by further packing, and death ensued thirteen hours later. Dr. Weir, in another case, would favour the application of hæmostatic forceps to the bleeding points, retaining them in place for twenty-four or forty-eight hours.

Growths from the Dura Mater.

The above are cases of growths from the brain itself.

Dr. Keen (*Am. Journ. Med. Sci.*, 1888) has published a most interesting case of fibroma, weighing over three ounces, attached to the dura mater, which he removed successfully in a patient aged twenty-seven. The growth probably dated to an injury in childhood. It caused epilepsy, aphasia, complete hemiplegia, intense neuralgia, deafness, and great impairment of vision. Save for the eye and ear symptoms, all the other had passed away except slowness of speech and the epilepsy, and the last was much improved.*

Tubercular Growths.—As a rule these should only be attacked when there is good reason to believe that the growths are primary and single. The frequency with which they are multiple is treated of below (p. 236). But where a tubercular growth is threatening to cause blindness, severe headache, constant vomiting, &c., it should be explored and removed if possible. Prof. Horsley (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365), is strongly in favour of operation. Where a trial of medical treatment for four months fails, such tubercular nodules are probably densely fibrous with caseated centres. Age, no doubt, has an important effect here. Thus, in a child, owing to the yielding skull, the presence of a tuberculous mass may be long unsuspected or ill-marked. The following is one of the most interesting of Prof. Horsley's successful cases (*Ibid.*, Oct. 9, 1886):

A man, aged twenty, began, in January 1884, to have cramps in the left thumb and forefinger, these consisting of clonic opposition of the above-named digits and occurring about twice a day for three months.

The first severe fit occurred March 1884; the second in January 1885. Then followed a series of remissions of the twitchings, until in August 1885 commenced a series of fits occurring once or twice a week until admission in December 1885.

The character of the fits was nearly always the same. They began by clonic spasmodic opposition of the left thumb and forefinger, the wrist next, and then

* Prof. Macewen (*Lancet*, August 11, 1888, p. 304) has published a case in which a tumour of the dura mater caused irritative lesions of the left frontal lobe. The patient was restored to perfect health, and died eight years later of Bright's disease.

the elbow and shoulder were flexed clonically, then the face twitched and the patient lost consciousness. The hand and eyes then turned to the left, and the left lower limb was drawn up. The right lower limb was next attacked, and finally the right upper limb. At frequent intervals every day the patient's thumb would commence twitching, but the progress of the convulsion could often be arrested by stretching the thumb or applying a ligature. Sensation was not affected. There was frequently severe headache, beginning at the occiput and shooting forward, especially to the right parietal region. The optic discs were normal. It was decided to explore the junction of the middle and lower thirds of the ascending frontal and parietal convolutions, a spot at which Prof. Horsley and Dr. Beevor had shown that the movement of opposition of the thumb and finger could be elicited.

On June 22, 1886, the seat of the lesion being determined by measurement, the 2-inch trephine was applied, and on removing the dura mater a tumour came into view. By further removal of bone the mass to which the dura mater was adherent was completely exposed. It stood out about $\frac{1}{8}$ inch from the surface of the brain, and was much denser than the brain substance. It appeared to be only $\frac{1}{2}$ inch broad, but as the brain substance all around it for more than $\frac{1}{2}$ inch appeared dusky and livid, the part apparently diseased was all freely removed. This was fully justified, since the growth spread widely under the cortex. Before closing the wound the centre of the thumb-area was removed by a free incision.* Numerous vessels were ligatured. The wound healed, and within two months the patient had regained everything, except that the grasp of the left hand was not quite so good as before.† There had been no fits since the operation. The tumour was composed of dense fibrous tissue, with two caseated foci, microscopical examination proving it to be tubercular.

Prof. Horsley (*Brit. Med. Journ.*, April 1887) has also removed a tubercular tumour from the right lobe of the cerebellum.

Death took place nineteen hours later, the patient having only partially recovered consciousness. Generalised chronic tubercle was found in the viscera. The operation was here performed as a *dernier ressort*.

Mr. Bennett May (*Lancet*, April 16, 1867) removed a similar growth from the right lobe of the cerebellum of a child.

The extreme bulging of the dura mater gave evidence of great intra-cranial pressure. The cortex appeared quite healthy, but at one spot palpation gave an ill-defined feeling of hardness. This spot being incised, the finger detected a hard mass nearly an inch below the surface. This was dug out with the handle of a small teaspoon. It was larger than a pigeon's egg, hard and horny outside and caseating in the centre. The hæmorrhage was trifling, but the patient sank from shock a few hours later. No autopsy was permitted.

The above cases are especially interesting from v. Bergmann's

* This detail Dr. Hughlings Jackson and Prof. Horsley had resolved to carry out in the possible event of there being no obvious, gross organic disease, in order to prevent, as far as possible, recurrence of the epilepsy.

* Dr. Hughlings Jackson, in the discussion on Prof. Horsley's paper, said that it was proved that the "thumb centre"—i.e., that part of the cortex in which the most special movements of the thumb are represented—had been cut out, by the fact that while the patient could move his thumb he had lost the most delicate movements of it. Even if the fits recurred, the patient was well rid of his tumour; if they did recur, Dr. Hughlings Jackson would advise removal of more of the cortex, believing it better to have some permanent paralysis than to be subject to fits becoming universal.

statement ("Die Chir. Behandlung Hirnkrankheiten": *Arch. f. Klin. Chir.*, Bd. xxxvi. 1888, Hft. 4), that it is not possible to enucleate tubercular matter in the brain with a sharp spoon as in the skin or bones. Time alone will show whether the belief of this surgeon is correct, that operation in these cases may favour the dissemination of the tubercle, giving rise to tubercular meningitis.

Gummata.—Some have expressed the opinion that here surgical interference is uncalled for. Thus, v. Bergmann (*loc. supra cit.*) has criticised Prof. Horsley for having operated on such a case. While no one will operate on a gumma of the brain till a sufficient trial has been given to mercury and potassium iodide* there is no doubt whatever that a syphilitic lesion may reach a stage here as elsewhere, in which it has quite got beyond the reach of specific remedies. Such a lesion, if localisable and to be got at, should be attacked, because if left alone it will go on causing trouble indefinitely, and further the compression and wasting of adjacent nerve-tissue which it will set up, will in time become irreparable.

Prof. Horsley, who is of opinion (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365) that cerebral gummata are not really cured by drugs, would certainly limit the trial of drugs to two months. He holds that gummata are here incurable, because there is always a certain degree of pachymeningitis around them, and that this is inevitably progressive.

The most interesting case of operation in these cases is one of Prof. Macewen's (*Lancet*, May 23, 1885).

In a patient, aged twenty-five, there was left-sided motor monoplegia of arm and leg, preceded by muscular twitchings and tingling sensations, without loss of sensation, due to syphilis, and resisting prolonged treatment. A cortical lesion of the right motor area, in the upper half of the ascending frontal and parietal convolutions, with probable involvement of the paracentral lobule, was diagnosed. A crown of bone over an inch in diameter, with its anterior border reaching to a point about half-inch behind the auriculo-bregmatic line, and its upper margin reaching to within half an inch from the centre of the superior longitudinal sinus, was removed. Its inner surface showed osteophytes. The dura mater was thickened and rough. Crucial flaps of this being reflected, a yellowish opaque effusion covered the brain, obscuring the convolutions and bridging the fissure of Rolando. This was very friable and came away in minute portions. Towards the upper part of the opening the brain offered resistance on palpation. This sensation proceeded from the interior of the brain, in the direction of the paracentral lobule, a layer of brain-tissue intervening between this more resistant structure and the finger. An incision being made through the upper part of the ascending parietal towards this firm structure, about two drachms of grumous fluid escaped. The resistance now disappeared, and cerebral pulsation was now, for the first time, feebly perceptible. The patient made a good recovery, regained sufficient power over the left side to enable her to walk two miles, and do her household work.

* The American method of pushing this drug in large doses at frequent intervals in milk (*Arch. of Medicine*, New York, Oct. 1884), is especially applicable here.

In the following case (Barton, *Ann. of Surg.*, January 1889) syphilitic necrosis of the frontal bone existed before the trephining:

Owing to this, the gummatous thickening of the dura mater found at the operation was fetid; this condition persisted, leading to hernia cerebri, and death about a month later. In this case, on incising the dura, characteristic gummatous deposit, yellow and cheesy, was discovered. It was very difficult to remove all this, as it was soft, friable, and firmly adherent to the walls of a cavity which it seemed to have hollowed out on the upper surface of the anterior lobe. The paralysis of the right arm and leg improved at first after the operation.

Cysts.—While the cerebellum appears prone to these formations, they occasionally occur after injury over the motor area, as in the two following cases (Macewen, *Brit. Med. Journ.*, Aug. 11, 1890):

Epilepsy (Jacksonian) induced by Focal Facio-lingual Lesion—Removal of Cyst from Brain—Cure.

A man, aged twenty-two, had epileptiform convulsions, each lasting from two to three minutes, with an average of over 100 in 24 hours. The convulsions were limited to the tongue, right facial muscles and platysma. When they subsided the parts remained paralysed. Consciousness was retained. Eight years previously he received an injury to the head, after which his right arm became weak, though he was able to work. It was clear that an irritating focal lesion existed, confined to the base of the ascending convolutions, causing a Jacksonian epilepsy. At the operation, in the lower part of the ascending frontal, a cyst about the size of a filbert was found situated partly in the cortical and partly in the white substance of the brain, surrounded by a narrow zone of encephalitis. In manipulating the medullary substance during the removal of the cyst, the patient, while under chloroform, had a convulsion similar to those prior to the operation. The convulsion ceased with the removal of the cyst, and he never had another. The wound healed firmly under one dressing, the paralysis of the facial muscles soon disappeared, and the patient has since been constantly at work. The power of the right arm has also increased. Possibly the cyst might have caused, indirectly, slight pressure on, or had set up inhibitory action of the middle part of the ascending frontal.

In another case in which brachio-crural monoplegia was present, with late rigidity, these dating to an injury eight months before, Prof. Macewen removed a large thick-walled, sub-dural cyst, containing clear fluid, which was pressing on the motor convolutions, together with a spiculum from the inner table, which had penetrated the brain. The paralysis, with the contraction of the muscles, passed off to a great extent. The patient could neither walk nor stand before the operation, afterwards he could run about, and use his hand well, though there was still paresis in both limbs.

Questions arising before Attacking a Cerebral Tumour.—The chief of these are: (A) The existence of a growth. (B) The site of the growth. (C) The depth of the growth. (D) Is it single or multiple? (E) Its nature. (F) Is it a case for operation, and if so, how far shall surgical interference be carried?

The above points, and the first five especially, must be decided with a physician; and it is to be hoped in future that physicians will invoke, at least, the opinion of the surgeon earlier than has hitherto been the case.

A few words will be said here on the questions of the nature

and multiplicity of the growth, and then as to the question of operative interference. I trust that the information given above, and the cases already quoted, will be helpful in deciding the above questions.

(E) *The Nature of the Tumour*.—Some help as to the varieties of growth most likely to be met with will be gained from the following table (Hale White, *Guy's Hosp. Rep.*, 1886).

Of a hundred cases of cerebral tumour the proportions were as follows :

Tubercle	45
Glioma	24
Glio-sarcoma	2
Sarcoma	10
Carcinoma	5
Lymphoma	1
Myxoma	1
Cyst	4
Gumma	5
Doubtful	3
	<hr/> 100

Of the forty-five cases of tubercle, the cerebrum was affected in twenty-two, the cerebellum in twenty cases. The growth was multiple in nineteen, and single in twenty-four cases. In all the forty-five cases one or more other structures than the brain were affected. Dr. White concludes that not more than three tubercular cases were likely to be benefited by operation, and even in these the other organs were tubercular.

Of the twenty-four cases of glioma, of ten only could it be said that they were not infiltrating. The cerebrum was the seat of the disease in thirteen cases, the cerebellum in four. In one case there were multiple gliomata in the brain, and in two others there were growths in other parts of the body.

Of the ten cases of sarcomata several affected the dura mater in inaccessible positions; of the five cases which attacked the brain only, one alone could have been removed with any prospect of success. Of the remaining tumours none of the carcinomata or glio-sarcomata were amenable to treatment. Of the four cases of cyst one could certainly, and another possibly, have been operated upon; the myxoma was, and the lymphoma was not, amenable to operation, and of the three doubtful cases, two could have been operated on. Dr. White's summing up is as follows: "Thus we see that out of one hundred cases of tumour of the brain, ten might certainly have been operated upon, and four additional ones might possibly have been, so that in 10 per cent. of our cases we can hold out some hope of operative relief to our patients, provided that a correct diagnosis of the position of the growth be made, even so late as shortly before their death, whilst, of course, earlier in their histories, many others might have been operated upon with a good prospect of success."

We come lastly to the most important of the questions from a surgeon's point of view: (F) **Is it a case for operation, and if so, how far shall surgical interference be carried?**

The following points are worthy of consideration before we come to a conclusion: (i.) *That we are here dealing with a peculiarly vital part.* I think that any candid surgeon, acquainted with the history and progress of his profession, will allow that in two directions the progress of antiseptic surgery has been less brilliant than might have been expected when its other triumphs are considered. The two referred to are: removal of cerebral growths compared with the other advances of cranial surgery, and the operative relief for acute intestinal obstruction compared with the brilliant successes in other branches of abdominal surgery. The explanation of this is not far to seek. I maintain it lies in the fact, to which due weight has not been attached, that with the brain and small intestine (with its association with the mesentery, solar plexus, &c.) are peculiarly vital structures, and that, however great advances may be made, this fact will remain unchanged. Along with the above go several other points. (ii.) *The operator should be a man well versed in general surgical technique of the present day, and with experience in brain surgery.* Nowadays, especially when the line between the hospital surgeon, who is habitually operating, and the general practitioner, whose experience is infinitely less, is, as regards operations, very much less sharply defined than it was twenty years ago, I would speak emphatically on this point. (iii.) *The operator, however experienced, should know when to stay his hand.* In these cases of cerebral growth, involving peculiarly vital parts—growths, often of much longer existence, and of larger size than has been suspected, nearly always difficult to identify, and especially so if sub-cortical—the surgeon may very readily be led on and on to do too much for his patient's strength. Happily, this is, in a measure, met by adopting the advice which Prof. Horsley and Prof. Macewen (*Brit. Med. Journ.*, vol. iii. 1893, p. 1367) have given, that the operation had often best be divided into two stages (*vide infra*). Again, the same authorities have shown that where removal is out of the question, a palliative trephining may, by the relief it gives to pressure, remove for a time such distressing symptoms as vomiting, headache, advancing optic neuritis, &c. With regard to this question of palliative operation, the words of Prof. Horsley (*loc. supra cit.*) are very suggestive: "In every case of glioma or glio-sarcoma that I have removed, the tumour has been of such a size as to render it uncertain at the time of the operation whether or no the complete removal had been effected; and in such cases, ultimately, recurrence has taken place."

Chief Difficulties and Dangers in Operations in Cerebral Tumours.—Some of these are enumerated now; they will be more fully dealt with in the next section:

(1) Sufficient exposure of the growth. (2) Embarrassments with

the anæsthetic. (3) Hæmorrhage. (4) Difficulty in detecting the growth. (5) Difficulty in isolating the growths.

(1) Sufficient exposure of the growth.

(2) Not only may much bone require removal (as in the case recorded, p. 231), but the patient's condition, from a tendency to coma, failing pulse, and respiration, aided by the effects of the anæsthetic (p. 165), may seriously embarrass the surgeon by cutting short the time needful for sufficient removal of the cranial bones.

(3) Hæmorrhage (pp. 231, 246).

TREPHINING FOR MICROCEPHALUS, IDIOCY, ETC. LINEAR CRANIECTOMY.

Lannelongue's suggestion of involving the aid of surgery in the treatment of imbecility, &c., aroused much interest, and in the last few years a large number of cases have been submitted to craniotomy or craniectomy, with a view of either removing some morbid condition or relieving pressure on the brain, or in some way stimulating its development.

Before we can decide how far such operations are likely to be established procedures we must consider what **pathological conditions are likely to be met with and how far they are remediable**. These appear to be (Starr) (i.) **Microcephalus**, whether due to premature closure of the cranial sutures (Virchow), or secondary to mal-development of the brain (Broca). In the following conditions the brain is at fault with or without marked microcephalus, and sclerosis and atrophy are met with in a varying degree in nearly all. (ii.) **Porencephalus**. By this is meant a localised atrophy, leaving a cavity in the cerebral hemispheres which may be deep enough to open into the lateral ventricle. (iii.) **Mal-development and atrophy of the minute structure of the cortex** of the hemispheres without any gross defects. (iv.) **Meningo-encephalitis** leading to thickening of the meninges and atrophy of the cortex. (v.) **Cysts** producing atrophy from pressure. (vi.) **Hæmorrhage** on or in the brain. (vii.) **Hydrocephalus**. This last will be considered separately. It is obvious, first, that many of the above are only to be recognised by exploration, and that many of them, if found, are hopeless of improvement. Thus it is clear that where sclerosis and atrophy are present to a marked degree, in cases of porencephalus, where one entire hemisphere is converted into a cystic cavity surrounded by shrunken brain-tissue and thickened arachnoid, interference will be futile. In the latter it may be fatal by the shock that will follow on the withdrawal of a relatively large amount of cerebro-spinal fluid. On the other hand, operation may prove beneficial in microcephalus with premature closure of the sutures, or in cases where a cyst is found or a surface hæmorrhage not too firmly organised. In all of these it is possible that development of the brain may be stimulated.

in others hemiplegia improved, and if the above fail by providing a safety-valve, epileptic fits, which are of such frequent occurrence in the above conditions, may be abated, and the operation thus prove a partial success. In recommending operative steps the wise surgeon will be careful not to be too sanguine, remembering the nature of many of the conditions which he may meet with and the impossibility of improving some of them. There is great weight in the words of the late Prof. Agnew that, "Nothing perhaps exhibits the enthusiasm of modern surgery more than these attempts to coax an undeveloped idiotic brain to execute the orderly functions of intelligence."

Furthermore it must be remembered that here, as in trephining for epilepsy (p. 192), cases have been reported much too soon to be looked upon as successes. The second point is that we are here dealing with very vital parts in patients of poor vitality, and that unless the surgeon is careful not to attempt too much, death from shock will be a very present danger.

Operation.—We will take first a case in which there is marked microcephalus, in which perhaps premature ossification of the fontanelles has been noticed. Lannelongue (*L'Union Médicale*, Juillet 8, 1890) operated in his first case as follows: Having made an incision through the scalp and pericranium just to the left of the sagittal suture, a small circle of bone was removed with a trephine, a finger's breadth from the suture, from this, as a starting-point, a narrow strip of bone was cut out parallel with and to the left of the sagittal suture, extending from the coronal to the lambdoidal suture. The periosteum was not replaced. Prof. Horsley removes the periosteum over the bone to be excised. This last step he effects by making parallel saw-cuts backwards and forwards from the trephine opening, and then removing the bone between the saw-cuts with sharp-pointed bone-forceps,* the dura mater being first detached with an elevator. In some cases, in addition to the removal of bone parallel to the sagittal suture, a second narrow strip has been removed over the corresponding fissure of Rolando.

Dr. Rowell Park (*Med. News*, Dec. 2, 1892) adopted this step in two cases, in one with great improvement, in the other with practically no good result. Prof. Horsley did the same in his second case, but considers it unwise and doing too much at one time. His case died with hyperpyrexia attributed to disturbance of "the cortical thermotaxic centres."

In other cases there is distinct asymmetry or evident mal-development of part of the skull, especially the frontal region, as in a case of Dr. Starr's (*loc. supra cit.*, p. 148), where a marked difference could be seen between the size of the frontal bone and that of the posterior part of the skull. Dr. McBurney operated as follows:

* Most surgeons would prefer to try Hoffmann's forceps first. In using this instrument, it must not be made to include too much bone within its bite, or one of its jaws will snap off. In this respect it is a treacherous instrument.

The object in view being to allow of growth of the frontal lobes, it was thought best to lift the bone away from the brain on both sides. The left side was first operated on, and two weeks later the right. A long semilunar incision was made in the scalp from the forehead near the temple backwards to the mid-parietal region, its convexity being upwards. A small trephine-opening was made at the summit of this incision, and, with this as a centre, a groove was chiselled in the bone, first downward and forward, then downward and backward. Thus, an omega-shaped groove in the skull was cut. The bone was then gently prised up, the short limb of the omega between its ends being broken. Thus a bony flap with scalp attached was raised about an inch away from the dura. The dura was not opened. The wound was dressed so as not to make pressure on this flap. The operation was followed by some improvement, but later information is much needed on this point.

In other cases where there is no evidence of microcephalus, and where attacks of an epileptic character, hemiplegia and aphasia may be due to a clot or cyst, the area suspected must be exposed in the usual way, by means of an appropriate flap (p. 244). If after opening the dura mater (which will here be probably much less tense than natural) an exploring needle draws off more fluid than would be expected from a cyst, the fluid is probably cerebro-spinal, and its evacuation should be at once stopped and the wound closed. Such cases are irremediable by any treatment.

Whatever operation is performed it should be completed as speedily as may be, and care should be taken not to do too much at one operation. Every precaution should be taken against shock, and if the hæmorrhage has been severe it may be useful to resort to infusion of saline fluid (p. 86).

Dangers of the Operation. — These are chiefly (1) Shock. (2) Hæmorrhage. (3) Injury to the dura mater, especially adherent, in children. (4) Septic changes in the wound, as these cases, restless and ill regulated in their behaviour, may make the maintenance of asepsis very difficult, especially in older and thus less easily managed patients, by tearing off by their bandages. (3) Hyperpyrexia.

TREPHINING IN GENERAL PARALYSIS OF THE INSANE.

As this operation has been recommended on the authority of Dr. Claye Shaw (*Brit. Med. Journ.*, vol. ii. 1889, p. 1090; vol. ii. 1891, p. 581) and Dr. J. Batty Tuke (*Ibid.*, vol. i. 1890, p. 8) it deserves mention here; but time alone will show whether I am right in saying that it does not appear one to deserve encouragement, even as a palliative step. It must not be forgotten that here is no morbid condition which can be cured, that the excess of fluid—the removal of which and so the relief of tension is the object of trephining—is variable, and while it is clear that the benefit given by the operation has been only temporary it must be remembered, as pointed out by Dr. J. Adam (*Brit. Med. Journ.*, vol. ii. 1889, p. 1187) and Dr. R. Percy Smith (*Ibid.*, vol. i. 1890, p. 11), that temporary periods of spontaneous marked improvement

are not uncommon. The operation promises to give most relief where marked headache or convulsive seizures are present and are not relieved by other treatment. Where the disease is advanced, and where the history of alcoholism is marked, the step should not be entertained.

Operation.—In the few cases recorded the trephine has been applied in the parietal region. Defined headache may help to localise its application. The dura mater should be opened and removed sufficiently to allow of free escape of fluid, and the pia mater, if oedematous, may be punctured. Draining should be provided by horsehair or a tube, if needful. Dr. Claye Shaw has advised (*Brit. Med. Journ.*, vol. ii. 1891, p. 583) tapping and draining the lateral ventricles. This step is described below. It would probably be difficult to keep up drainage for any useful period in many of these patients, and the histories of general paralysis of the insane do not suggest the existence of much intra-cranial pressure such as surgeons are familiar with in hydrocephalus. In conclusion, while I should add that I have no personal experience of the operation, it does not seem to me to be one based on sound pathological evidence, or justified by success.

TREPHINING FOR DRAINAGE OF THE LATERAL VENTRICLES.

It is well known that distension of the ventricles with a fluid largely cerebro-spinal does occur, causing symptoms closely similar to those of cerebral growth. It is natural therefore, as treatment by medicine is useless, that surgery should be resorted to. Unfortunately, in the majority of the cases, the distension of the ventricles is only secondary to some disease in the cerebellum, corpora quadrigemina or crura cerebri, pressing on the veins of Galen, or, as Mr. Hilton showed years ago,* to occlusion of the cerebro-spinal opening in the fourth ventricle—all forms of disease equally hopeless. In a few cases the collection of fluid is due to meningitis, often tubercular. Every operating surgeon of any experience has tapped the ventricles through a lateral angle of the anterior fontanelle, with the result of often giving marked relief, obviously, from the nature of the cause, only temporary, convulsions and coma carrying off the patient after a varying interval. The antiseptic method has not aided us here, owing to the conditions at the root of the mischief; withdrawal of the fluid slowly by a Southey's tube has been equally unsuccessful.

With a view of ensuring more gradual drainage and some alteration in the lining membrane, the following operation has been performed.

Trephining for Drainage of the Lateral Ventricle.—Prof.

* "Rest and Pain," Lectures ii. and iii. Mr. Hilton first noted this fact in 1844.

Keen, of Philadelphia, was one of the first to draw attention to this proceeding (*Med. News*, Sept. 20, 1890).

In one case the patient was a boy, aged four, with hydrocephalus and rapidly developing blindness, due, as proved later, to a growth of the cerebellum pressing on the straight sinus. The left ventricle was reached by trephining at a spot $1\frac{1}{4}$ inch above and behind the auditory meatus* and by puncturing the brain with a needle directed towards a point $2\frac{1}{2}$ inches above the opposite meatus. At a depth of about $1\frac{1}{4}$ inches resistance to the needle suddenly ceased, and cerebrospinal fluid escaped. Three double horsehairs were then introduced and the needle withdrawn. Drainage thus established was kept up for fourteen days, when the horsehair was replaced by a drainage-tube.† On the twenty-eighth day after the operation, the symptoms returning, a corresponding operation was performed upon the right side, and a drainage tube passed directly into the ventricle. The child died on the forty-fifth day.

The second and third cases died four days and four hours after the tapping. In the second the operation was just like that in the first, but as, on replacing the horsehair drain by a tube, the escape of fluid appeared to be too free, the tube on each side was plugged. Then convulsions set in, and it being concluded that too much fluid had escaped, warm water was allowed to run into the ventricle. This was done repeatedly, the introduction of an ounce of warm water each time arresting the convulsions, but the child soon died.

Mr. Mayo Robson (*Brit. Med. Journ.*, 1890, vol. ii. p. 1292) was more successful, but it will be seen that his case differs widely from those in which fluid usually collects in the ventricles.

The case was probably one of meningitis, localised to the left posterior and middle fossæ, with otitis media of the left ear. Right hemiplegia supervened, and in the hope of finding an abscess the skull was trephined over the situation of the motor centre for the arm. An exploring needle failing to find pus, the needle was pushed into the lateral ventricle withdrawing six drachms of clear fluid, on which pulsation returned in the brain. The hemiplegia gradually disappeared, and six months later the child was well, save for occasional recurrence of slight convulsive seizures limited to the right arm.

As will be seen at once, this case, though most interesting as probably a case of cure of meningitis due to otitis media, is totally different from the cases which usually call for tapping and drainage of the lateral ventricles. Thus, in this case but one ventricle was affected, the surroundings were much more healthy, and there was no general internal compression of the brain. In another case Mr. Robson drained one ventricle for hydrocephalus following on treatment of spina bifida by Morton's fluid. This case, as is the rule, died in convulsions a few days later.

The only case which recovered from the operation is one of Broca's (*Rév. de Chir.*, Jan. 1891), but the date at which the report breaks off makes it of very little value.

The patient, aged four, was an imbecile suffering from hydrocephalus, and a contraction of the upper extremity, which had followed on convulsions. The skull was trephined at the spot chosen by Prof. Keen, and sixty grammes of fluid withdrawn. A drainage-tube passed through the cannula was allowed to drain into the gauze

* Some consider this spot too near to the lateral sinus, and advise placing the trephine $\frac{1}{2}$ inch higher.

† This is best done by means of a Lister's sinus-forceps.

dressings, which were changed every day or two. On the sixteenth day very marked improvement was noted, the contraction in the right upper extremity having disappeared. The fluid gradually ceased to drain away, and by the fiftieth day the wound had entirely healed, and the child was discharged very much improved physically and mentally.

OPERATIVE PROCEDURES ON THE BRAIN, CHIEFLY FOR THE REMOVAL OF GROWTHS.*

Preparation of the Patient.—The day before the operation the patient's head is shaved, washed with soft soap and then ether; next, the position of the lesion is ascertained by measurement, and marked on the scalp with iodine or silver nitrate solution. The head is then covered with lint soaked in carbolic-acid solution (1 in 20), oil-silk and cotton wool, being thus thoroughly carbolised for at least twelve hours before the operation. Finally, the patient has the usual purgative administered the evening before, followed by an enema on the morning of the operation. Any course of bromides should be suspended for a week before the operation.

Anæsthetic.—If not contra-indicated a hypodermic injection of a quarter of a grain of morphine† is given, and then chloroform is administered. The object of giving the morphine is twofold, in the first place it allows of the performance of a prolonged operation, without the necessity of giving a large amount of chloroform, the amount actually used in an operation lasting two hours being very small.

The second reason is perhaps the more important, that this drug causes well-marked contraction of the arterioles of the central nervous system, and that consequently an incision into the brain is accompanied by very little oozing, if the patient be under its influence. Prof. Horsley has not used ether in men, fearing that it would produce cerebral excitement; chloroform, on the contrary, producing well-marked depression. But if much tendency to shock existed, or if it be needful to keep the head raised, the

* Many other operations on the brain—*e.g.*, for abscess, removal of bullets—have been already fully considered. Several instances of removal of growths have also been given in the preceding pages. Prof. Horsley (*Brit. Med. Journ.*, Oct. 9, 1886, and April 23, 1887) first insisted on the majority of the details above given.

† In one case, a child of four, one-twentieth of a grain was found amply sufficient. The advisability of a preliminary injection of morphia has been a good deal disputed. Dr. F. W. Hewitt, in his most careful work on *Anæsthetics*, p. 274, thus puts the matter succinctly: "In feeble or exhausted patients, in those who are lethargic or semi-comatose, and in those with any respiratory difficulty, I am convinced that the advantages obtainable from morphine are not sufficiently weighty to counterbalance the risks attendant upon its employment." When morphine is contra-indicated, 3j-3ij of the liquid extract of ergot may be given half an hour before the operation, as advised by Prof. Keen.

above theoretical considerations would be disregarded in favour of the safer anæsthetic,* or the A.C.E. mixture.

Treatment of the Wound.—The high mortality accompanying trephining being largely due to septic meningitis, strict antiseptic precautions will alone give safety.

Line of Incision.—Prof. Horsley disapproves of the ordinary crucial incision as inconvenient at the time, as the four flaps have to be held out of the way, and later on their point of meeting, a weak spot, may aid the formation of a hernia cerebri. If, on the contrary, a semilunar flap be raised, it can simply be thrown back and requires no more holding; later on, the advantage of such a large flap, which can be laid down like the lid of a box, will be obvious since, being continuous throughout, it offers plenty of resistance to the upward pushing brain, which the point of meeting of four cross-cuts can never do; this indeed, on the contrary, favouring the very thing one wishes to avoid. The following details with reference to raising the flap will not be out of place here:—(1) All the parts superficial to the periosteum must be raised with the flaps. (2) The curve must be a shallow arc to avoid cutting collateral vessels. (3) It must be so drawn as not to divide the main arterial branches supplying that part of the scalp. The periosteum should be reflected by a crucial incision from an area corresponding to the first trephine hole, and subsequently as more bone is cut away. The hæmorrhage from any large flap is very free: it is best met by cutting the flap boldly, compressing the incision as it is made with sponges, and then catching the vessels, one by one, as the sponges are lifted.

It is usually important to indicate on the bone itself, by the previous use of a small drill, the site of the first trephine-opening. Careful outlining of this on the shaven scalp will be of no avail after the flap has been lifted away. Measuring instruments have to be used again, perhaps without disinfection.

Removal of the Bone.—The cranial opening should always be sufficiently free. A cramped opening is certain to defeat the object of the operation in the case of a growth. Where exploration has to be made, the most rapid way is to make a couple of holes with a 2-inch trephine at the opposite extremities of the area to be removed, then to cut half through the sides of such an area with a Hey's saw, and, finally, to complete the division with a powerful bone-forceps, or the intervening bone may be nibbled away with Hoffman's forceps.† Whatever instrument is used to

* Attention is also called to the startling rapidity with which a patient, who has roused up in the middle of one of these prolonged operations, can be sent off again, in a moment, with only a few whiffs of the drug, and that thus it is very easy to give too much in a brief space of time. Prof. Horsley expresses a strong opinion that this sensitiveness to the action of the anæsthetic is more marked when the dura mater is opened.

† A trephine worked by an electric motor or surgical engine requires much skill and care in maintaining the dura mater uninjured. I strongly advise prac-

divide the bone after the trephining, a copper spatula should be introduced at the opening to separate the dura mater freely, and to protect this as the saw or forceps are used. Where it is possible to preserve the dura mater intact, the portions of bone removed should be preserved in hot aseptic lotion, and, at the end of the operation, placed between the skin and dura mater.*

When the bone removed is only of moderate size, *e.g.*, that of an ordinary trephine crown, it may be replaced in one piece, especially in young subjects, the vitality of older bone is better secured by subdividing it (Macewen). Where a large area of the brain has been exposed, it will be well, in order to preserve the contour of the skull, to replace the whole piece. To provide drainage and prevent necrosis, any such large piece should be deeply notched, or freely punched or drilled with holes, so that a lattice-work and not solid bone is left.

The method of removing a large flap of soft parts and bone, by cutting through it with a chisel, which has found favour in Germany (Wagner) and America (Hartley, MacBurney), is condemned by Prof. Horsley as harmful and inexpedient: harmful because hammering the skull must increase the shock, and inexpedient inasmuch as the pericranium has no osteogenetic power, and, therefore, it is a matter of no moment whether it is retained in contact with the bone or no.

Operation in Two Stages.—To avoid shock, so fatal in these cases, the above course has been advised by Prof. Horsley and Macewen. The latter also had adopted it for five years, and gave (*loc. supra cit.*) three striking cases in proof of its value. This step, in which the skull is first sufficiently opened, and at the second, some days later, the growth removed, if possible, not only diminishes shock, but also by soldering the membranes at the margin of the exposed brain, shuts off the sub-dural space, and so prevents the escape of blood into it.

Treatment of the Dura Mater.—This should be incised round four-fifths of the circumference of the area exposed at $\frac{1}{8}$ inch distance from the edge of the bone, so as to render it possible to stitch the edges together afterwards. The dura mater is best opened first by incision with a scalpel or sharp-pointed bistoury, and then by blunt-pointed curved scissors, great care being taken not to wound the parts beneath: tenaculum-forceps will be found useful here. The main branches of the middle meningeal are best secured by underrunning before they are divided. The dura mater should be raised with much gentleness, as if any adhesions are torn, very free venous hæmorrhage may result.

ice and familiarity with a full sized trephine, a good Hey's saw, and Hoffmann's cutting-forceps.

* Though the vitality of the fragments has invariably been perfectly preserved, Prof. Horsley has not, so far, observed much ossification of the cicatrix. Where a large area of bone has been removed, a perforated celluloid cap, light, but very strong, is recommended.

*Treatment of the Brain.**—If this, after incision of the dura mater, bulges very prominently into the wound, it indicates pathological intra-cranial tension, and probably a tumour.† Alterations in the density of the brain must next be observed, but it must be remembered that cerebral tumours, situated beneath the cortex, are scarcely to be detected, save by exploratory incision. Dr. Weir (*loc. supra cit.*) thinks a needle of very little value in exploration of a growth. A tumour too soft to be detected by the finger will not be recognised by the needle. Furthermore, two cases have come to Prof. Keen's knowledge in which fatal hæmorrhage followed its use. Careful palpation and the insinuation of the finger-tip under the trephine-opening are preferable. Prof. Keen (*loc. supra cit.*) points out that the brain allows of gentle pressure very readily, and that the finger can be inserted for purpose of examination an inch all round the opening.

Hæmorrhage.—In removing a portion of the brain, or a tumour, the bleeding which has been so much dreaded will usually cease if the wound be packed for a few minutes with strips of iodoform gauze wrung out in carbolic acid lotion (1 in 20). If it recur, the strips must be left in. The value of a preliminary injection of morphine has already been alluded to, and Prof. Horsley further points out that, owing to the fact of the main vessels remaining in the pia mater they can be raised from the brain, and especially out of the sulci, so as to allow of the subjacent brain being removed; other means of arresting hæmorrhage are boiling water, cooled to 105° or 110° ; cocaine 10 per cent. (Keen); fine catgut ligatures tied without jerking, and not too tightly. If any bleeding vessel is not well within reach, the opening must be enlarged to get at it. Where other methods fail

* Any of the dura mater which is adherent to the tumour is usually much altered. If the mischief is recent, the membrane will be simply highly vascular. In advanced cases it may be yellowish, and in some instances, on separating it from the growth beneath, it is found to be of a dirty reddish colour. In all cases where it is adherent the dura mater must be freely excised.

† In some cases where there is abundant evidence of intra-cranial tension a growth may be present, but out of the range of the operation. Thus, in a case in which Dr. Weir (*Ann. of Surg.*, June 1887) trephined over the upper part of the right fissure of Rolando for spasms in the left limbs and loss of power in the left leg, no growth was found. Death took place ten weeks later, and a spindle-celled sarcoma apparently originating in the pia mater was found springing from the lower surface of the left cerebellar lobe, displacing the medulla forwards to the right, and invading the fourth ventricle. Dr. L. S. Pilcher (*Ann. of Surg.*, March 1889) relates the case of a man who presented symptoms which, though not very definite, were not inconsistent with the existence of a growth in the angular gyrus, or its immediate vicinity, the site of a previous injury. Trephining being performed, the dura mater and brain projected so strongly that, after the former had been reflected, a rent took place in the cortical portion $\frac{1}{4}$ inch deep. No growth was found, and the patient died thirty-eight hours later with pulmonary œdema. The autopsy showed an infiltrating glioma in "the anterior half of the left hemisphere."

Spencer Wells' forceps may be left on for 36 or 48 hours; but the patient must be carefully watched, lest his restlessness cause the friable tissues to give way, or inflict damage on his brain. The treatment of hæmorrhage from the meningeal or diploic vessels, or any of the large venous sinuses, has been given at pp. 185, 169.

Incision of the Brain.—The cuts in the cortex must be made exactly vertical to the surface. If possible, portions of each centre should always be left, so that the representation of its movements may never be totally destroyed. A portion of brain removed does not leave, as might have been supposed, a permanent gap with vertical sides, for, in a very short time, the corona radiata forming the floor of the pit bulges almost to a level with the surrounding cortex.

*Difficulty in Detecting the Growth.**—This may arise from several causes. (1) The want of distinctness in the growth—in other words, its close resemblance to brain substance.† (2) By the growth being overlaid by normal brain substance (pp. 228, 246). (3) By change in the growth—viz., hæmorrhage from its thin-walled vessels, and later on caseation of the coagula, these conditions being likely to puzzle the operator.

Difficulty in Isolating the Growth.—(1) This may be due to the absence of a capsule, and thus to the infiltration of the surrounding parts. Now that gliomata, owing to the operative attacks which will be made upon them, are of such practical importance from a new point of view, this question of a capsule is a very weighty one. It seems to be a disputed point. Thus, in Dr. Bennett's and Mr. Godlee's case the glioma was found to be "thinly encapsuled, but quite isolated from the surrounding brain substance." Not so, however, is it in many other cases. Indeed, the chief pathologists speak decisively on this point. Dr. Fagge (*loc. supra cit.*) wrote: The substance of glioma "is always continuous with that of the surrounding cerebral tissue, for there is never a capsule‡ as with some sarcomata. Indeed, it often assumes the form of the part in which it grows, so that one might imagine the corpus striatum or the thalamus, or some particular convolution, to have become swollen to three or four times its usual size."

(2) Another source of doubt in telling when a glioma not encapsulated has been isolated, arises from the fact that, as pointed out by Dr. Fagge (*loc. supra cit.*), these growths, in common with all the less circumscribed form of cerebral tumours, are apt to set

* I have confined myself here to gliomata, the commonest of cerebral tumours.

† "A glioma may be of a pinkish-red colour, or it may look so exactly like the normal brain-substance that a microscope is required to demonstrate its presence."—Dr. Fagge, *Medicine*, vol. i. p. 523.

‡ The glioma "is distinguished by having no capsule, but merging indefinitely into the tissue around. It is firm and tough, otherwise very like brain-tissue, but more pellucid."—Dr. Wilks and Dr. Moxon, *Path. Anat.*, p. 239.

up morbid changes in their immediate vicinity, usually of the nature of softening, partly inflammatory, partly oedematous.

If a cyst is found it should be completely removed if possible. If this is not feasible, all the more superficial part should be cut away, the interior wiped over with a stick of silver nitrate, and packed with iodoform gauze.

Excision of Cortex Centres for Epilepsy.—As this is an operation which may be tried in the future, it will be well to mention one case. Prof. Keen, of Philadelphia (*Am. Journ. Med. Sci.*, Oct. and Nov. 1888), successfully excised the centre for left wrist and hand in an epileptic whose fits always began in the left hand.

The patient, aged twenty, had had a fall on his head when thirteen. There were no definite traces of this, and exploration of the part which had possibly been struck detected nothing abnormal. Each fit invariably began in the left arm and fingers. The thumb and fingers became rigid and extended, widely separated, the hand and forearm in a right line, and the elbow flexed. Usually both legs were next attacked, the left usually before the right, and crossed in front of it; next the face was attacked, the mouth being drawn to the left. After this the convulsions became general.

The fissure of Rolando being marked on the scalp; in order to indicate it on the skull itself, two small incisions were made at the ends of the line, and with a bone gouge two small circles were made through these on the skull. A $1\frac{1}{2}$ inch trephine was then applied with the centre-pin $\frac{1}{8}$ inch behind the fissure of Rolando, the lower margin of the trephine being about $\frac{1}{4}$ inch above the temporal ridge. The crown was placed in 1-2000 bichloride solution, carefully kept at T. 100° – 105° . The bone and dura mater both appeared normal; no bulging was observed, and the pulsation was regular. The dura was now incised. The pia was very much infiltrated with serum, producing an oedematous layer much obscuring the brain-tissue, especially the sulci over all this area. Two convolutions, running obliquely downwards and forwards, crossed the trephine opening, while at the anterior border a third convolution, with, apparently, a like direction, came into view. An attempt was made to determine which was the Rolando fissure by examining the depths of the sulci, but as both were about 1 inch deep, this gave no clue. By the cyrtometer (disinfected) the position of the fissure of Rolando was re-determined. This ran in the middle of the three convolutions. To determine the seat of the hand-centre a faradic battery was used, the ends of the wires being wrapped in borated cotton dipped in bichloride solution. Stimulating the two posterior convolutions gave no results. When the anterior one of the three was touched the hand instantly moved, the wrist and fingers being extended. Above this centre were the shoulder and elbow centres, and below that for the face. The opening in the skull was now enlarged, and the portion of the hand-centre about $1\frac{1}{2}$ inch long, as ascertained by the battery, was then incised above and below with a knife, the lower incision being $\frac{3}{8}$ inch above the temporal ridge. The lower end of the portion to be removed was then lifted up, and the loosened convolution cut away with scissors. While this was done, no movement was perceived. The battery wires were now again applied. At the remaining part of the convolution above, flexure and extension of the left elbow, elevation and abduction of the shoulder were noticed. Touching the part remaining below produced an upward movement of the whole left face. The large vessels in the brain were extremely gently tied with chromic gut, and oozing checked by hot water and cocaine (4 per cent.). The dura mater was sewn with chromic gut, two bundles of horsehair being placed beneath it. The disc of bone and some fifteen pieces removed were replaced on the dura. Soon after the

patient recovered from the ether he had a fit, but the hand did not move. The patient made a good recovery, and a month after the operation the skull was as firm on one side as the other, with very slight, if any, irregularity where the pieces of bone were replaced. The fits were greatly diminished, and only of a momentary character, practically *petit mal*. There was no convulsive movement whatever; the hands and wrist were as before. Seven weeks after the operation the patient wrote that motion was returning in the left hand. Dr. Keen thought that by "compensation" it was nearly certain that in time control over the left hand would be regained through the other hand centre.

The above remarks refer to attempts to remove certain definitely localised small centres. The following words of Prof. Macewen (*Brit. Med. Journ.*, Aug. 11, 1888) have an important bearing on this matter, and, from his wide experience, carry great weight. "Can the motor area be removed in large pieces with immunity from serious consequences? If this region be of such psychical importance to movement, and destructive cortical lesions in it are followed by secondary degeneration of the motor tracts, then excision of these areas will necessarily induce permanent paralysis, late rigidity, and ultimate structural contracture. The removal of large wedges from the brain, especially in the motor centres, will produce serious effects upon the brain as a whole, causing, during cicatrisation, a dragging and displacement of the neighbouring parts, with final anchoring of the cerebrum to the cicatrix.* . . . In the presence of a stationary cicatrix, or a slow-growing neoplasm in the motor area, occasionally producing fits, few would attempt the removal of such a large wedge of the motor region as to induce permanent hemiplegia. Even when the fits are much more numerous and aggravated, it is serious to contemplate the production of hemiplegia while attempting the cure of the fits.

* "*Anchoring of the Brain and some of its Consequences.*—When injury has been inflicted on the surface of the cerebrum, followed by plastic effusion and cicatricial formation, the superficial substance is apt to become soldered to the membranes when these remain intact, which in turn may be soldered to the skull, or, in the event of their detachment, the brain may become directly adherent to the bone. Thus, the surface of the brain becomes anchored or soldered to its rigid walls. It has no longer the free play within its water-bed to expand and contract according to the varying states of the circulation. Each variation produces a dragging of the brain at the spot, and through it the whole hemisphere at least is affected. Any sudden physical effort pulls on the brain, producing a slight shock, a momentary disturbance just as if the cerebrum had received a blow. Vertigo results. People affected in this way cannot rise up quickly, or perform any sudden movement of the body or head, without experiencing a sensation of giddiness, which sometimes causes them to drop. Following upon this, the grey matter of the cortex, immediately surrounding the cicatrix, by the incessant movement is apt to become unstable and produce fits. Some cases of traumatic epilepsy are thus caused. Further, if the cortical irritation be continued, encephalitis is occasionally produced, often appearing in a chronic form and long remaining so, though susceptible of being lit up into an acute affection. If the temperature remain high, active interference is apt to induce an extension of the encephalitis. Operation in such cases should be, when possible, postponed. The disregard of this advice has, to my knowledge, in one instance, hastened the fatal issue, encephalitis becoming rapidly general."

No doubt these epilepsies, when long continued, especially in early life, are apt to lead to great and extensive instability of the motor cortex, so as to warp the whole cerebral function, and ultimately involve life itself. Still, how much better is the cure by the removal of a large wedge, involving the greater part of the motor area? How many people would submit to have their upper and lower limbs on the same side of the body amputated at their proximal points—for this is what the hemiplegia amounts to—in the process of cure of their fits. Numerous epileptics have been asked the question by me, but none have expressed their willingness to undergo such a cure. Even had they done so, the circumstances would require to have been exceptional to induce one to hazard the life of the patient for so poor a result. . . . Nor is the removal of very large tumours and large wedges of brain free from immediate peril to life. In several instances operated on elsewhere death has ensued—one while the tumour was being removed, and one immediately after the completion of the operation."

Closure of the Wound.—All bleeding having stopped, the cut dura mater is sutured with fine catgut, and the pieces of bone are placed on it. If the brain bulges much when the dura mater is being sutured, it should be depressed with a copper spatula, while the edges of the dura are quickly sutured by a continuous catgut suture. Room must be left for drainage, and the flap secured with medium-sized silk and horsehair sutures. Prof. Horsley removes the drainage-tube, which is to be inserted at the most dependent part of the incision (as the patient lies in bed) at the end of twenty-four hours, and makes firm but gentle pressure over the centre of the flap. The tube serves to remove the steady oozing of blood and serum from the cut surfaces, which takes place during the first twenty-four hours, and its removal at the end of this time is advised, in order to allow of a certain amount of tension of wound exudation to occur within the cavity, this tension not interfering with primary union if kept within proper bounds, while it secures pressure on the brain which is tending to extrude, and serves, when the wound is finally healed, to separate the skin flap from the brain beneath by a cushion of soft connective tissue. If, after the removal of the tube, there is much pain and throbbing in the wound, and the union threatens to break down, the edges must be sufficiently separated with a probe, gently used, in the track of the drainage-tube.

Causes of difficulty in cerebral operations and of their not doing well:

1. The anæsthetic not being well taken (p. 165).
2. Hæmorrhage (pp. 231, 246). In two cases the hæmorrhage has occurred some little time after the operation, and has been due to the vomiting after the anæsthetic.
3. Shock (p. 233).
4. Œdema of the lungs.—This is especially likely after pro-

longed operations, where it has been needful to give ether, and in cases where, for some time before the operation, the patient has been practically bedridden, and the functions at a very low ebb.

5. *Hernia cerebri*.—This may occur in two ways: (a) Immediately, during the operation, in a case where there is much evidence of intra-cranial pressure, and where it has not been possible to remove the cause. Thus, in Dr. Pilcher's case (*loc. supra cit.*), the projecting cerebral mass was so great in volume and so tense that there was no possibility of returning it within the cranial cavity, nor of covering it by the usual flaps. Accordingly it was sliced down to the level of the bone. (b) Later on, it may point to unrelieved tension, as in a case of mine of cerebral abscess to which I have alluded (p. 209) and in which a good recovery took place after evacuation of the re-collection of pus. In such a case constant pressure with the aid of a piece of sheet-lead, notched or perforated for the drainage tube will be found most useful. In other and more numerous cases a later *hernia cerebri* points to septic changes. Dr. Macewen thus points out another cause: "It is true that round many neoplasms there is a zone of encephalitis, and should this be extensive and of the nature of red softening, false *hernia cerebri* is prone to form. It was supposed that false *hernia cerebri* was entirely due to decomposition, many recent writers averring that it cannot occur unless when operations are conducted non-antiseptically, basing their belief on experimental investigations conducted on brains in a physiological state. Had they concluded that the formation of false *hernia cerebri*, after operations, was principally caused by decomposition, and always so when it occurred after operations on a physiological cerebrum, they would have been right. The consistence of false *hernia cerebri* is identical with red softening of the brain, occurring in idiopathic affections in which there had been no operation. In one instance, in which trephining was performed for the relief of pressure causing total hemiplegia, and when the symptoms indicated either acute encephalitis or abscess, or both, the moment the *dura mater* was opened a large mass of encephalitis protruded through the membranes, forming a false *hernia cerebri* on the surface of the scalp. This encephalitis was not occasioned by septic matter introduced through a wound, as it occurred the moment the wound was made. Around neoplasms red softening sometimes exists, and interference might possibly occasion an extension of the affection, though were the operation conducted with strict antiseptic precautions, the possibility of its formation would be reduced to a minimum. With this exception, there has been no false *hernia cerebri* after any of my operations."

6. *Septicæmia*.

7. Impossibility of complete removal.

8. Recurrence.

In some cases where the growth has not been found, or where its complete removal has not been possible, the symptoms have

been materially improved by the relief given to the pressure. Thus, in the *Lancet* of April 7, 1888, a case under the care of Mr. F. A. Heath is reported, in which, though the tumour was not removed, owing to adhesions to the anterior fossa, the benefit derived from the relief given to the pressure was most decided.

The patient recovered promptly from the operation, with the formation of a hernia under the healed scalp, shortly after regained a considerable power of motion in the paretic limbs, remained free from epileptic attacks for over two months, and for a long time was rid of the headache. He was seen thirteen months after the operation, and though completely blind could walk about very well. Of late the headache had returned, and the epileptic attacks had become more frequent.

The following case of Fischer's, of Breslau (*Centr. f. Chir.*, Bd. xxix. 1889), bears on the same point.

A patient was admitted with complete paralysis of the right arm, which had been coming on for a year, and very severe headache on the left side. The right leg was also weaker, dragging a little in walking. The left pre-central convolution was exposed, but no trace of a tumour could be found. The patient experienced great relief from the operation. The headache was gone, the arm paralysis was less, and the convulsions ceased. Five months later the patient began to complain again, the paralysis of the right arm and leg having increased, and epileptiform seizures being of daily occurrence. He urged repetition of the operation. The skull being again opened at the same place, a red lobulated tumour soon bulged up. It was shelled out piecemeal with the finger, as it continually broke off on pulling, severe hæmorrhage resulting. The growth was also firmly adherent to the dura. The hole in the brain was lightly plugged with iodoform gauze. All symptoms of growth were again in abeyance. Two months later the patient began to complain again, and now a growth grew through the trephine opening. The autopsy showed that the growth in the brain had been completely removed. The recurrence started from the dura. It was a vascular round-celled sarcoma.

CHAPTER IV.

OPERATIONS ON THE FACE.

OPERATIONS ON THE FIFTH NERVE.

As the surgeon will not be called in until all other treatment has failed, and the patient is desirous of relief, as radical as may be, neurectomy alone will be described here.

With regard to the two operations, neurectomy and nerve-stretching, I think the respective value may be summed up in some such way as this. It would appear from Wagner's * laborious collection of 135 cases of neurectomy, that 18 remained cured after as long a period as three years. I am unable to find any case of nerve-stretching reported as cured after a longer period of watching than eight months.†

First Division of Fifth Nerve: Neurectomy.

Neurectomy.—The incision should be horizontal, and lie below the margin of the eyebrow, thus leaving little scar. The supra-orbital notch, being made out ‡ by firm pressure when the patient is under an anæsthetic, the eyebrow is drawn up and the eyelid down, and an incision an inch and a half long is made along the supra-orbital margin, with its centre opposite to the notch. The skin, occipito-frontalis, orbicularis, and palpebral ligament being divided, the cellular tissue is separated, the nerve found in the notch, set free, traced back as far as possible so as to include the supra-trochlear if possible, drawn up with a strabismus hook and

* *Arch. f. Chir.*, Bd. xi.

† For a reference to the statistics of Hahn, of Berlin, quoted by Dr. Chandler in his tabulation of cases (*New York Med. Record*), and for Dr. Gray's tables (*Journ. of Neurology and Psychiatry*, May 1882), I am indebted to a paper by Dr. G. R. Fowler (*Annals of Surgery*, vol. iii. No. 4, p. 269), which for its fulness and impartiality is well worthy of reference. For the more detailed and recent account of these and all operations on nerves, I would refer my readers to M. Chipault's *Chir. Opér. du Système Nerveux*, t. i. t. ii., Paris, 1895.

‡ "The supra-orbital notch or foramen can be felt about the junction of the inner with the middle third of the supra-orbital margin. From this point a perpendicular line, drawn with a slight inclination outwards, so as to cross the interval between the two bicuspid teeth in both jaws, passes over the infra-orbital and the mental foramina. The direction of these two lower foramina looks towards the angle of the nose."—Mr. Holden, *Landmarks, Medical and Surgical*, p. 6.

a full inch removed. The wound should be closed with a few horsehair sutures.

To facilitate this step, the orbital fat must be depressed with a copper spatula. The vessels are usually wounded, and give a little trouble. As with the other branches of the fifth, the supra-orbital often appears smaller than it does in the dissecting-room.

Supra-trochlear Nerve.—In an inveterate case of neuralgia of the first division of the fifth nerve, if the surgeon does not feel sure that he has in the preceding operation got behind the point of origin of the supra-trochlear, this nerve must be cut down upon. Sir W. Mac Cormac (*Operations*, part ii. p. 467), gives the following advice: "The position of the supra-trochlear nerve is indicated by an imaginary line drawn from the outer angle of the mouth through the inner canthus of the eye to the orbital margin; at this point the nerve will be found as a single branch, or as two or three slender filaments, escaping from the orbit above the pulley of the superior oblique. . . . To reach the nerve, make a convex incision at the superior internal angle of the orbit, immediately below the eyebrow, and search for the pulley of the superior oblique, above which the nerve runs."

Second Division of Fifth Nerve: Neurectomy and Nerve-Stretching.

Neurectomy.—Cases justifying: epileptiform neuralgia resisting all other treatment—*e.g.*, extraction of teeth, the continuous current, &c. Cases in which life is a burden, where, owing to the frequent recurrence from the slightest touch, from a draught of air, or taking food,* the patient is unfit for work, sleepless and emaciating, and, perhaps, becoming a morphia-habitué.

Doubtful Cases.—Cases in which the neuralgia is ascending—viz., attacking first the inferior dental, then the superior maxillary, and so on, in spite of operation. Here the severer operation given at p. 259 may be required. If other conditions are favourable, age does not necessarily prohibit the operation.†

Operations.—These may be classed under three heads. A. **Antral**, the nerve being reached from the front through the anterior and posterior wall of the antrum. B. **Orbital**. This method is a modification of the first. The advantage is that the antrum is not opened, the nerve being followed back in its canal in the floor of the orbit

* In a patient of Dr. Fowler's (*Annals of Surgery*, vol. iii. No. 4, p. 300) "every attempt to receive food upon that side of the mouth was followed by exacerbations of pain, of the most frightful character. It was only by lying upon the opposite side, and having a funnel passed back to the pharynx, so as to guide the stream away from the diseased side, that he was enabled to take food at all, and that of a liquid character."

† Dr. Maclean, of Detroit, in a discussion on "a Case of Excision of the Inferior Dental Nerve, by Dr. Mears" (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 485), mentioned two cases of men, aged seventy-two and sixty-nine, in the first of whom he excised the infra-orbital and inferior dental; and in the second, the supra- and infra-orbital nerves successfully, the good result having lasted six years in the first case.

(Wagner, Horsley). As Prof. Horsley (*Brit. Med. Journ.*, vol. ii. 1891, p. 1142) allows that in this method the antrum is liable to be opened—though if this happen the inconvenience is slight—and as the antral method gives more room for what is a difficult operation, I do not recommend the orbital modification. C. **Pterygo-maxillary**, Lücke (*Zeitsch. f. Chir.*, 1875), Lössen (*Centr. f. Chir.*, 1876), Braun (*Centr. f. Chir.*, 1882). Here the nerve is reached in the sphenomaxillary fossa, not from the front, but at the side, by an operation which turns down the zygoma and masseter, and is similar to that described as Rose's (p. 259). The advantages claimed are that the antrum is not opened, an objection to which I have alluded above. Again, the scar being placed at the side is less prominent when the patient is looked at full face. In reply to this, I would say that in the only case (p. 262) in which I have performed Carnochan's operation, the scar was subsequently very little noticeable. As I look upon the pterygo-maxillary operation as graver than Carnochan's, more troublesome from bleeding, more risky of grave septic results from its relations (*e.g.*, the pterygoid plexus), and more certain to be followed by stiffness of the jaw, I should only perform it in cases where it was probable that the third division should be resected at the foramen ovale, as well as the second in the sphenomaxillary fossa, or at the foramen rotundum.

Antral Operation.—This, often known as Carnochan's, has the advantage of removing the whole of the second division of the fifth, together with the sphenopalatine ganglion as far back as the foramen rotundum, the nerve forming the guide to the surgeon from the surface backwards.

Carnochan (*Amer. Journ. Med. Sci.*, 1858, p. 136) looked upon the removal of Meckel's ganglion as the key of the operation. Whether his view was right that this body could be likened to a galvanic battery, keeping up a continuous supply of "morbid nervous sensibility," there is no doubt that removal of the nerve *beyond* the ganglion is strongly advisable, as by this step the sphenopalatine branches to the gums are also removed. As pointed out by Mr. Chavasse (*Med. Chir. Trans.*, vol. lxxvii. p. 151) and Mr. Clutton (*St. Thomas's Hosp. Repts.*, vol. xv. p. 213) removal of the nerve *beyond* Meckel's ganglion ensures the disconnection of the posterior dental nerve* from the brain, which is probably the explanation of the success which follows the operation.

An anæsthetic being given, and the parts shaved† and cleansed,

* In both of Mr. Chavasse's cases the commencement of the pain was invariably referred to the periphery of the posterior dental branches, and it appeared very doubtful if stretching would have had any effect on slender branches at some distance from the extension point. Both of Mr. Chavasse's cases remained practically well two years and a year and a half after the operation.

† In one of Mr. Clutton's cases this could not have been borne before. Recurrence, slight and relieved by quinine, ensued in both of Mr. Clutton's cases within the year.

a T-incision is made with the horizontal portion reaching from canthus to canthus just below the orbit, and the vertical one running down close to the angle of the mouth. The flaps thus marked out being reflected and all hæmorrhage stopped, the infra-orbital nerve is defined, cut as long as possible, and a piece of silk tied round it to make it serve as a guide.

A $\frac{1}{2}$ -inch trephine is then applied just below, and including, the infra-orbital foramen, so as to remove the anterior wall of the antrum; next, the same sized or a $\frac{1}{4}$ -inch trephine is applied to the posterior wall of this cavity so as to expose the sphe-no-maxillary fossa. Free and troublesome hæmorrhage must be expected, partly from the vascular facial bone,* partly from the mucous membrane of the antrum, and in the fossa itself, where the bleeding is always copious, from the terminal branches of the internal maxillary. Pressure with small sponges in holders may be relied upon. The next step is to open up the infra-orbital canal with a small chisel; strong scissors, or fine cutting pliers, being used to enlarge the wound.

During the operation, if daylight fail, a laryngeal mirror and artificial, or electric, light, will greatly help the surgeon.

The nerve being now brought into the posterior trephine-aperture, it is traced into the sphe-no-maxillary fossa, which it enters through the foramen rotundum. Being kept on the stretch by means of the piece of silk, it is severed with long, delicate, curved scissors as far back and as near the foramen as possible. If it is still held by filaments passing downwards (sphe-no-palatine branches), these should be also divided with scissors. Mr. Clutton considers that the total length of nerve removed from the infra-orbital foramen to the foramen rotundum should be at least $1\frac{3}{4}$ inch, without including any of its branches. Iodoform should be dusted in at once, and the wound plugged temporarily with carbolised sponges sprinkled with iodoform. When all hæmorrhage has stopped these are removed, and the sphe-no-maxillary fossa and antrum are lightly plugged with aseptic gauze, wrung out of carbolic acid (1 in 20). The flaps are partially adjusted with a few points of suture, leaving room for drainage and the removal of the strips,† iodoform dusted on, and boracic acid-lint wrung out of the same lotion iced, applied constantly and renewed frequently for the first few days, or dry gauze dressings applied.

Difficulties which may be met with During the Operation.—

1. Hæmorrhage. 2. The nerve breaking, or being divided prematurely. 3. A deep wound, difficult to illuminate, especially if the antrum is deep between the two trephine wounds.

After any of these operations on the fifth nerve the patient should be strictly cautioned to avoid exposure to any of the

* The superficial hæmorrhage will be all the freer in proportion as the part has been recently submitted to blistering, liniments, &c.

† To be removed in twenty-four or forty-eight hours according to the amount of hæmorrhage met with during the operation.

causes of a return of his enemy. The chief are given below (p. 268).

Operations on the Third Division of the Fifth Nerve.

—I shall describe here neurectomy, first of the inferior dental, a nerve so commonly the seat of neuralgia; then of the lingual gustatory, which is much less frequently affected; and, lastly, operations by which the trunk can be reached at the foramen ovale, part of the Gasserian ganglion removed, and the second division attacked at the same time.

Inferior Dental: Neurectomy.—This nerve may be attacked in three places—at the mental foramen, in the dental canal, and above the dental canal. Experience has shown that the relief after the first two methods is so transitory that the higher operation should always be resorted to. The best method is that by which the nerve is reached by widening the sigmoid notch. This is practically an old operation of Velpeau's, much improved and modified according to the needs of modern surgery by Prof. Horsley (*Brit. Med. Journ.*, vol. ii. 1891, p. 119), and Mr. Rose (*ibid.*, vol. i. 1892, p. 160). The face having been shaved and cleansed; the external meatus cleansed and plugged with aseptic wool, the patient is placed under an anæsthetic, and an incision is made, starting from about the middle of the zygoma, and passing backwards and downwards in front of the tragus to the angle of the jaw, and then forwards as far as a spot just behind the facial artery. The flap, consisting of skin and superficial fascia only, is raised forwards as far as the anterior border of the masseter, and the edge of the parotid and the lower border of Stenon's duct are then clearly defined. The greatest care must be taken during the above step not to divide any of the branches of the facial nerve or to injure any of the lobules of the parotid gland. The flap having been turned forward and covered by an aseptic sponge, the next step is to divide the masseteric fascia and muscle down to the bone, horizontally between Stenon's duct and the highest branch of the facial nerve below it. The muscle and periosteum are next separated by blunt raspatories with sufficient freedom to expose the sigmoid notch and the adjacent parts of the coronoid and condyloid process. Smart oozing must be expected from the masseteric artery, and arrested by firmly applied sponge-pressure. The next step consists in enlarging the sigmoid notch as far as the upper orifice of the dental canal. This is done by applying a $\frac{3}{4}$ -inch trephine, applied so as to leave between it and the notch a narrow bridge of bone, subsequently clipped away with bone forceps. Great care must be taken, owing to the varying thickness of the bone, in the use of the trephine; otherwise the inferior dental artery will be wounded or the bone fractured.* The bone having been removed sufficiently, some loose yellow fat usually

* To avoid this last complication Prof. Horsley advises first drilling the bone with a row of holes along the line of the part to be removed, and then cutting it out with curved bone-forceps (*loc. supra cit.* p. 1193, Fig. 2).

comes into view, and, to avoid bleeding, the inferior dental and the internal maxillary, if this be in the way, should be secured between two ligatures. The inferior dental nerve is next identified and secured by a silk ligature. The external pterygoid having been levered upwards or divided if needful, the nerve is followed close up to the foramen ovale, and divided as high up and as low down as possible. The lingual nerve, which lies somewhat anteriorly and on a deeper plane, is then treated in a similar way. Any venous bleeding which cannot be dealt with by ligature should be met by firm pressure with aseptic sponges. Irrigation with lot. hyd. perch. (1 in 4000), used at intervals, is now repeated. the wound carefully dried out, a small drainage-tube inserted, if there be still much oozing or if the parts have been much disturbed, and the wound united with horsehair sutures.

Lingual Gustatory : Neurectomy within the Mouth.

—In a few cases of epithelioma of the tongue not admitting of removal, this operation may be performed in the hope of relieving the pain and diminishing the rapidity of the growth, the profuseness of the foetid dribbling saliva, &c. In another small group of cases neuralgia of the tongue resisting other treatment, this operation may be resorted to with entire success, as in the following case :

Mrs. A. D., aged forty-seven, was sent to me in October 1894 by Surgeon Captain Salvage, stationed at Woolwich, for stretching or neurectomy of the right lingual. I had seen this patient at intervals for the preceding five months for severe neuralgia of the right side of the tongue. For this many of the patient's teeth on that side had been removed, and by my advice the local application of menthol, injections of morphia into the tongue, quinine internally, and change of air and rest had all been fully tried without the least benefit. Oct. 11.—Ether having been given, the mouth well opened in a good light, and the tongue drawn over to the opposite side, an incision was made in the fold of mucous membrane between the right side of the tongue and the gums, the centre of the incision being opposite to where the last molar tooth should have been. The nerve having been exposed where it is lying under the mucous membrane just before it dips under the mylo-hyoid, was raised with an aneurism-needle and a full inch removed.* The only after-treatment consisted in painting the wound occasionally with a solution of cocain, and the frequent use of Condyl's fluid as a mouth wash. The patient went out ten days later, having completely lost her neuralgia. This relief continued two months later, but the case, though most encouraging, must be watched for a much longer time before it can be considered conclusive.

Removal, more or less complete, of Gasserian Ganglion. Neurectomy of Third and Second Division of Fifth Nerve in front of the Ganglion. Division of Sensory Root of Fifth Nerve.

The above operations are justified by the fact that, as a rule, neuralgia returns within a period of nine months to two years after neurectomy of the trunks and branches of the fifth nerve by

* The above operation, made use of by Continental surgeons for many years—Roser, of Marburg, having introduced the principle in 1855—is now known in France as the method of Létiévant (*Chalot Chir. Opérat.* p. 134).

any other operative steps. How far these far graver operations will produce complete cures must at present be uncertain, as no cases have as yet been watched sufficiently long.*

The above operative steps can be here described under the following heads:—

A. Extra-cranial Method.—By this the ganglion and the second and third branches are reached by trephining at the base of the skull from without. This method has been brought into prominence in this country by Mr. W. Rose, whose name it bears.

Intra-cranial Method.—Here the ganglion and the nerve trunks are got at within the middle fossa, the attack being made through the side of the skull (Horsley, Wagner, Hartley).

A. Extra-cranial Method: Rose's Operation.†—Stage i. *Reflection of Skin Flap.*—The operative area and the external meatus are first carefully sterilised (p. 243), and the eyelids secured in apposition by horsehair sutures. The incision through the skin and superficial fascia only is made from a point near the outer canthus, about half an inch below the external angular process of the frontal bone, backwards along the upper border of the zygoma to its posterior extremity, then downwards just in front of the ear to the angle of the jaw, and finally forwards along the horizontal ramus as far as the facial vessels. The semi-circular skin flap is raised without any damage to the facial nerve or Stenson's duct, and is carefully protected with a gauze dressing from any drops of the anæsthetic or other contamination. Stage ii. *Exposure of the Pterygoid Space.*—An incision having been made along the whole length of the zygoma, the periosteum is carefully detached. Two holes are then drilled through the root of the zygoma,‡ and two anteriorly through the zygomatic process of the malar bone. These are to admit of subsequent wiring of the bone and so to ensure union without necrosis. The bone is then divided between them, posteriorly as near the root of the zygoma as possible, anteriorly in a direction obliquely downwards and forwards. The zygoma is then displaced downwards and backwards together with the masseter, this step being facilitated by the division of the muscular fibres attached anteriorly to the malar bone. Some loose cellular tissue being next removed, the coronoid process and temporal tendon are exposed, and the former process is divided

* Thus, in only one of Mr. Rose's cases (*loc. supra cit.*) had a period of two years elapsed between the operation and the publication of the case. In none of Dr. Hartley's cases (*Ann. of Surg.*, vol. i. 1893, p. 509) operated on by himself and other surgeons, and in none of the four cases operated on by Dr. Tiffaney (*ibid.*, vol. i. 1894, p. 47) had two years elapsed. In truth, in some of these cases the report is only carried up to a few months after the operation, and in two to only eighteen and nine days after.

† Mr. Rose has described this operation with full details (*Brit. Med. Journ.*, vol. i. 1892, p. 261).

‡ In my case I dispensed with the first two. The wound, though tested severely (p. 262), healed by primary union.

obliquely downwards and forwards as low down as possible. It is then turned upwards and, with the tendon, cut away, as owing to the subsequent wasting of the muscles of mastication there is no object in leaving it, and every additional atom of space will be found most helpful in a wound-area so small and so crowded with important structures. Stage iii. *Exposure of the Foramen Ovale.*—It is here that the real difficulties of what is one of the most complicated operations in surgery commence. Removal of a little cellular fatty tissue will expose the external pterygoid, and, probably, the internal maxillary artery lying upon it. This vessel having been divided and removed between two ligatures, the inferior dental and lingual gustatory should next be identified (if not divided at a previous operation) at the lower border of the muscle and secured with silk ligatures as guides. I may here remind my younger readers that these nerve trunks are much softer and look smaller in life than they do in the dissected subject. In order to expose the foramen, the muscle is removed partly by picking it away piecemeal with forceps, partly by scraping with raspatories. By this means the under surface of the great wing of the sphenoid and the external pterygoid plate are exposed. The foramen ovale is now to be brought into view, a matter often of great difficulty, and occasional reference to a skull held by an assistant will be a considerable help in indicating its position to the surrounding structures. Its relation—usually a little behind and external—to the root of the external pterygoid plate is one of the best guides, but this is not quite constant. Following up the nerves by means of the silk ligature, is, after all, the only reliable guide to the foramen, and to placing a probe in it. The chief difficulties here are (1) the very contracted space in which the operator has to work very deeply, with important structures hampering him by their closeness—*e.g.*, the foramen spinosum and middle meningeal artery, and the Eustachian tube which lie just internal and posterior to the foramen. The operator should keep scrupulously in front* of the foramen. (2) The bleeding. In my case alluded to below, the venous oozing met with as soon as the pterygoid space was opened up was constant and baffling. It came not only from the pterygoid venous plexus, but from small veins passing through what proved later to be the foramen ovale, and communicating between the above plexus and the cavernous sinus, and also from others unnamed perforating the base of the skull. This oozing, which quickly flooded the small space which is all one has to work in, was arrested by firm sponge pressure, but as soon as the work of

* Mr. Rose writes (*loc. supra cit.*): "The portion of bone which one first reaches in the deep part of the operation is well in front of the foramen, and one is apt to get too far forward, so that the pterygo-maxillary fissure is mistaken for it. In the third of my cases this actually occurred, and I trephined the sides of the fissure, not discovering my mistake until I found orbital fat protruding from the opening."

picking away the external pterygoid so as to define the base of the skull was resumed, it started afresh, and this necessitated the administration of so much anæsthetic as to compel me, after the base of the skull had been trephined, to send the patient back to bed and to complete the operation a few days later. I have heard of one case in which the operation was abandoned on account of this bleeding. Stage iv. *Opening the Base of the Skull*.—A trephine* should be applied to the great wing of the sphenoid, at a spot a little anterior and external to the foramen,† and in such a way, if possible, that its disc just impinges on the outer wall of the foramen. As the skull is thinner on the outer margin of the trephine track than on the inner, and as the instrument is applied at an angle, Mr. Rose's caution about the dura mater should be remembered here. Stage v. *Division of the Nerve Trunks and Partial Removal of the Ganglion*.—Any bridge of bone between the trephine opening and the foramen having been cut away, and the opening enlarged sufficiently with Hoffmann's forceps set at different angles, gouge, or chisel and mallet, the trunk of the third division with its silk guide attached, is traced up to the ganglion, which is gently loosened from its resting place on the petrous bone. The posterior part of it should then be carefully removed, the third and second divisions are then resected widely, but no attempt should be made to isolate, and divide the first. Stage vi. *Closure of the Wound*.—All bleeding having been checked, the irrigation with lot. hyd. perch. (1-4000), which has been continued at intervals, thoroughly carried out, the wound completely dried, iodoform or Jeyes' powder is well dusted in, the zygoma is adjusted and secured by silver wire, and the wound sutured accurately with a few points of horsehair. No drainage tube is needed if the above precautions are carefully attended to. The stitches from the eyelid may be removed at the end of three or four days, at which date a smaller dressing of aseptic gauze, sealed on with collodion, will probably suffice for the wound.

From my experience of one case, I would suggest that when the bleeding is profuse, and the operation prolonged, it may be well to perform this complicated and most difficult operation in two stages. My case was as follows:

Mr. G., aged forty-seven, a patient of Dr. Galton, of Brixton, came first under my care in 1892 for inveterate neuralgia of the fifth nerve, chiefly affecting the second division. For this the nerve had been already stretched at the infra-orbital foramen: the relief given by this step was so temporary as to be futile. In Oct.

* A special one is made by Mr. Hawksley, 357 Oxford Street, of small disc, with teeth adapted to the thickness of bone to be cut through, and a long handle to meet the depth of the wound.

† In Mr. Rose's first four cases the trephine was placed, with a blunt pointed centre-pin, in the foramen, so as to remove a disc of bone half an inch in diameter, with the foramen as its centre. The occurrence of epistaxis and coffee-ground-like vomiting in one case (this eventually did quite well) made it probable that the Eustachian tube had been encroached upon (*vide supra*, p. 260), thus running the risk also of septic contamination from the pharynx.

1893, I performed Carnochan's operation, which gave relief for nine months. At the end of 1894 the patient came to me with return of pain in the palate and back of the upper jaw, and evidence that the third and first divisions were also affected. Rose's operation was performed at Guy's Hospital, March 22, 1895. Mr. Rose's full account of each step would have rendered this operation comparatively easy had it not been for the baffling venous oozing which took place constantly while I was clearing the external pterygoid out of the pterygoid fossa in order to expose fully the foramen ovale (*vide supra*, p. 260). Then the frequent delays entailed by the needful sponge pressure, and the caution (perhaps excessive on my part) expended in trephining the base of the skull, so prolonged the operation and the anæsthetic that I was compelled to have the patient replaced in bed after removing the crown of bone, but without completing the operation. I may add that in spite of the care taken, a slight trickling of cerebro-spinal fluid showed that the dura mater had somewhere been pricked, though I could not detect any injury. The patient, after recovery from his collapse, had no bad symptoms of any kind, and on March 27 I opened up the wound, cleared a few clots out of the pterygoid fossa and by tracing up the third division by means of a short guide of silk which had been fastened at the previous operation, I defined the foramen, and, after cutting away a bridge of bone between this and the trephine opening, which had been placed well in front of and a little external to it, enlarged the opening with gouge and mallet and a small pair of Hoffmann's forceps. I was now able, by following up the third division, to remove the posterior and lower part of the ganglion, and also to divide and resect the second division of the nerve; the third division, including the lingual and inferior dental, the auriculo-temporal and buccal, both of which could be recognised, were also resected. The zygoma having been replaced, this was wired anteriorly to the malar bone, and the skin-flap again sutured with a few points of horsehair. No drainage was employed, but the strictest aseptic precautions were made use of. This wound having been dressed, I took the opportunity, as the right frontal area was hyperæsthetic, of cutting down on the first division and resecting a part of this. No bad results followed on the opening up of the wound; the patient went out three weeks after the operation, the old pain having disappeared, but any report at such a short interval of time is, of course, of little value.

(B) Intra-cranial Operation. i. Prof. Horsley's Operation.—In this the Gasserian ganglion is reached by exposing the temporo-sphenoidal lobe, and then by carefully raising the brain with a broad retractor, exposing the middle fossa. A large temporal flap is made, starting from the anterior extremity of the zygomatic process, running upwards to the temporal ridge, following that line, and descending along it to the posterior or junction of the squamous and lambdoidal sutures. The flap having been reflected, the whole of the squamous bone is removed by a trephine hole and suitable bone-forceps. Anteriorly the middle meningeal artery should be ligatured where exposed in the dura mater. The temporo-sphenoidal lobe is next exposed by opening the dura mater along the full length of the bone laid bare. The above lobe is partly moulded, partly lifted upwards by means of a broad copper retractor gently slipped under it, and the floor of the skull is then easily illuminated with the electric light. The lobe being raised a little more, the upper border of the petrous bone and the edge of the tentorium, which are the guides to the nerve, must be defined. The site of the canal in which the nerve is lying just above the

ganglion must then be estimated, and a small puncturing incision made into it. When it is recognised, the dura mater over the nerve is further slit open. Prof. Horsley, in the only case in which, as far as I am aware, he has published the results of this operation, passed a blunt hook around the nerve behind the ganglion, and, to avoid hæmorrhage from the small branch of the basilar which he believes to accompany the nerve, by gently drawing on the nerve with the hook, tore it away from its attachment to the pons. It is noteworthy that at the moment of avulsion, though the patient was well under the anæsthetic, there was an arrest of respiration, and the pulse could not be felt. This lasted for a few seconds only. The patient never rallied from the operation, "and died seven hours after, obviously from shock."

With all deference to Prof. Horsley, I cannot but think the course adopted here of avulsion of the sensory or great root of the fifth, an unfortunate one. When one remembers the association of this sensory root by its ascending root with the fourth ventricle, and the numerous nuclei so closely packed there, and the medulla, one is not surprised that respiration and circulation failed at the moment of avulsion, and that the operation was followed by fatal shock. Had the root been divided after isolation, the result would probably have been very different, though division of the great sensory root would appear likely to risk destruction of the eye, as followed in two cases treated by Mr. Rose's method, one a case of his own, and one other, at least, with which I am acquainted.

ii. **Hartley's Operation.**—This intra-cranial neurectomy differs from Prof. Horsley's in the following important details. The dura mater is not opened but raised with the brain from the middle fossa. Instead of attempting to divide the sensory root behind the ganglion, the second and third divisions are found in front of this body, and resected, and part of the ganglion removed if desired. Its steps are thus given (*Annals of Surgery*, 1893, p. 509). An omega-shaped incision is made, having its base at the zygoma, and marked by a line drawn from the external angular process to the tragus. From each end of this base the curved and rounded part of the incision reaches as high as the supra-temporal ridge. The incision is first carried down to the periosteum, and the membrane then divided upon the bone. With a chisel* a groove is cut in the bone along the line of the divided periosteum, this groove going down to the vitreous plate, except above where it includes the vitreous. An elevator is inserted here to snap the bone along the chiselled line. In this way the bone is fractured along the lower part of the incision, and a flap, consisting of skin, muscle, periosteum and bone,† is thrown down exposing the dura mater over a circular area of three inches in diameter. The

* The chisels, of special make, are figured by Dr. Hartley.

† If needful the sides of the incision in the bone can be lengthened with bone-forceps; the ends of the incision in the bone below should be quite on a level with the zygoma.

dura mater is next separated from the bone and the middle meningeal tied, if injured by being torn out of its groove. The dura mater and the brain are now carefully separated from the middle fossa with the finger, and raised with broad retractors (highly polished in order to reflect the light) so as to expose the foramen ovale and rotundum. The site of the carotid artery and the cavernous sinus can also be defined. The second and third divisions are then isolated at their foramina, divided, their cut ends secured with forceps or silk as guides and traced up, after the dura mater over them has been divided, as far as the Gasserian ganglion. Then the part of each between the ganglion and the edge already cut is resected. If it be desired, the dura mater over the ganglion is next raised, and the posterior part of the ganglion removed. As the amount of nerve trunks removed is not great, the cut ends of the nerves are pushed into the foramina, so as to interfere with any reunion. The wound having been carefully dried out, the brain and dura mater are replaced, and the flap laid down again. The irregular edge of the vitreous acts as a shelf on which the flap rests and prevents its falling in upon the dura mater. Five cases are given, four of which were operated on by Dr. Hartley and other American surgeons, the fifth is a case of Prof. Krause's, of Altona. All recovered, and all are stated to have been entirely relieved of their neuralgia, though in some the report is only carried forward for a few weeks after the operation.

Comparing these intra-cranial methods together and with that of Mr. Rose, it will be seen that Prof. Horsley's, in its division of the dura mater, is the severer. I have already spoken of my objection to avulsion of the great sensory root, but it is right to add that Krause claims (*loc. supra cit.* and *Deuts. Med. Woch.*, 1893, No. 15), by seizing the posterior part of the ganglion with Thiersch's forceps and carefully twisting, to have brought away the entire trifacial root and the ganglion. The first division is left torn loose very near the ganglion. The course of these cases after the operation is stated to have been good; in none has the pain returned. As, however, the above remarks as to the need of a full time test apply to these cases, as equally good results seem to have been secured by the milder method of Hartley, and other surgeons also have followed him, I should, at present, be content with this.

In comparison of the intra-cranial method of Hartley with the extra-cranial which bears Mr. Rose's name, I must say for myself that when performing this operation again, I should, after the difficulty which I met with (p. 262), be inclined to adopt Hartley's operation, with the exception that I should prefer to make the bone incision by a trephine opening, and saw and forceps, so as to avoid

* Prof. Krause and Dr. Hartley originated independently, and within a very few months of each other, an operation which is practically the same. Prof. Krause (*Ann. of Surg.*, vol. ii. 1893, p. 362), claims the priority.

the vibrations of the chisel and mallet.* In four of the five cases given by Dr. Hartley, the operation seems to have been simple and straightforward.† In one reported by Krause, the hæmorrhage which occurred during the raising of the dura mater from the bone was far greater than in any of the other cases. In these it yielded to sponge pressure, but in Krause's case it was so profuse as to necessitate, as in my case, performance of the operation in two stages. The cavity was packed with iodoform gauze, and five days later this packing was removed. The nerve was then found and resected. It should also be noted that in Dr. Hartley's case, during "the retraction of the dura mater, owing to imperfect instruments, the third, fourth and fifth nerves were somewhat injured." The ptosis, &c., which followed, in the end entirely disappeared. Another important complication not mentioned by Dr. Hartley, but met by Dr. Tiffany, is the free escape of cerebro-spinal fluid in two of the four cases operated on by the latter surgeon, occurring in one at the time of injury of the middle meningeal, in the other while the dura mater was being raised from the base of the skull.

STRETCHING THE FACIAL NERVE.‡

As will be seen from the remarks made below (p. 267), it is extremely doubtful if anything more than temporary relief, of a variable duration, can be promised by it.

Operation.—The following account is taken from Mr. Godlee's paper (*Clin. Soc. Trans.*, vol. xiv. p. 45); the method is that of Baum.§ An incision begun behind the ear, about opposite to the meatus, was carried downwards and forwards to a point immediately below the lobule, and then prolonged almost perpendicularly, but slanting a little forwards, nearly to the angle of the jaw. A small transverse incision was also made below the pinna. After

* It is fair, however, to Dr. Hartley that he specially states that in none of the cases was there any evidence that the vibrations necessarily transmitted to the brain were in any way harmful.

† It is noteworthy that three of these were performed by different surgeons; two alone fell to the lot of one man. In reading Mr. Rose's account of his method and in weighing his recommendation of it, we must remember that he is speaking from a personal experience of five cases.

‡ The operation given below, that of Baum, is not, accurately speaking, one quite on the face. It may, however, be conveniently considered here.

§ The other method is that of Hueter—by an incision 2 inches long in front of the ear, its centre being opposite to the upper part of the lobule. Prof. Keen (*Annals of Surgery*, July 1886, p. 13) gives the following reasons for preferring that of Baum: (1) The scar is hidden behind the ear, a point of much importance in women, in whom this affection is not uncommon; (2) It is less bloody; (3) it inflicts less damage on the parotid; (4) it reaches the nerve directly at its emergence from the stylo-mastoid foramen, before it has given off any branches except, perhaps, the posterior auricular. Thus there is no risk, as in Hueter's method, of the branches to the occipito-frontalis and orbicularis escaping. The above advantages outweigh the greater ease of Hueter's operation.

exposing the edge of the sterno-mastoid and parotid, these structures were separated deeply and pulled respectively backwards and forwards. As soon as the edge of the digastric appeared, the knife was discarded, and the structures immediately above and parallel with the upper border of the muscle were one after the other pulled up with a blunt hook or forceps and cleaned with a steel director. When the nerve was reached and raised on the hook, the twitching at first increased, a somewhat firmer pull averted it for a time, but it began again on relaxing the tension; a still firmer pull not only stopped the twitching, but caused the right side of the face to pass into a state of complete paralysis. One or two further pulls were given, and the wound closed. The operation was antiseptic throughout. Healing was complete about the ninth day.*

The performance of this operation is easy in thin patients; in stout and muscular ones it would be decidedly difficult. In different experiments on the dead subject the amount of tension which the nerve would bear differed very much; in some cases it resisted for an appreciable time the strongest possible pull, in others it snapped across with the greatest readiness.

The line for the nerve is exactly parallel with the upper border of the digastric, and it will be found about half-way down that part of the mastoid process which is exposed in the wound—viz., the free anterior border. The great auricular nerve will be in part divided, but as long as the operator keeps in the same plane as the digastric he can scarcely wound any vessel of importance. The deep parts of the wound are in close proximity to the internal jugular vein. The only vessels which should be met with are the posterior auricular vein superficially and its artery more deeply, but a good deal of hæmorrhage may arise from glandular branches, and Mr. Godlee's advice to keep the wound in a good light, well opened out with retractors, and carefully sponged dry, should be remembered.

Points which Deserve Attention.—(1) Finding the nerve. To avoid needless injury and to shorten the operation, Prof. Keen† found a weak faradic current very useful. A wet sponge was held on the cheek, and a fine wire at the other end was applied to various points in the wound till the nerve was found.

(2) Mode of stretching the nerve. Prof. Keen advises stretching from the periphery towards the centre. The amount of force to be used he estimates at four to five pounds, and that this can best be achieved empirically, by attempting to lift the head (six to seven pounds), and abandoning the attempt the moment any fibres

* The surgeon must be prepared for what took place in Mr. Godlee's case—viz., some troublesome conjunctivitis from the gaping of the lids, which was relieved by mildly astringent collyria, and holding up the lower lid with plaster.

† *Loc. supra cit.*, p. 13. In the moist condition of the wound a strong current will produce muscular spasm at once, but a very weak current will only do so when the nerve is touched.

give way. In other words, the stretchings should be as severe as the integrity of the nerve will allow.*

(3) Results of the operation. It appears that while many cases have been, temporarily, very much relieved, as a certain rule, when the nerve recovers itself, the spasms return.

Prof. Keen in the table at the end of his paper gives two cases in which the cure lasted much longer, if, indeed, it may not be called permanent—viz., Southam's,† in which there was absolute relief for five years, and one under the care of Jesus,‡ in which the cure had lasted two years and eight months.

Prof. Keen's concluding words are as follows: "It would seem therefore, that, whether viewed from the point of palliation, or of cure, the operation is, with our present knowledge, to be looked upon favourably. Further observations may show its inutility, but when we consider the utter hopelessness of improvement, much less recovery, from any other means, relief by this operation, even if temporary, is had at a very trivial cost, and would be welcomed by any sufferer, while permanent cure is not impossible."

Mr. Godlee in a second paper,§ in which he published the result of his first case—after practically remaining absent for nine months, the convulsions suddenly returned after a severe nervous shock, and gradually increased until they regained all their former intensity—sums up less favourably: "In discussing the question of recommending the operation to a patient, we must not forget that the risk, with due care, is almost nil; that a certain immunity from the trouble may be safely promised for a time, and that this period may be very considerably prolonged, and, while Southam's remarkable case remains completely well, there is always the hope that the relief may be permanent. Were it not for this, however, I am afraid that the general verdict would be that the time has come when this small chapter of surgical therapeutics . . . must be closed."

It is, of course, to be understood that no patient would be advised to submit to the operation without a thorough trial of other remedies, short of nerve-stretching.

And, after submitting to stretching of the nerve, patients should be most careful to avoid any exciting and predisposing causes of a

* Two cases are quoted—those of Eulenberg and Schüssler—in the first of which the nerve was "physically disorganised" by the stretching, while in the second the nerve lay in a small loop in the cavity of the wound; yet in each the paralysis gradually disappeared and the spasms partially returned.

† *Lancet*, August 27, 1881; *Ibid.*, April 10, 1886.

‡ *Wien. Med. Woch.*, No. 2, 1884, and No. 27, 1887. It is an interesting fact that no paralysis followed in this case.

§ Both Mr. Godlee's second paper (*Clin. Soc. Trans.*, vol. xvi. p. 220) and Prof. Keen's (*loc. supra cit.*) contain tables, the former giving thirteen, the latter twenty-one cases. Mr. Godlee's case was unwilling to purchase relief from her complaint by submitting to permanent paralysis of the affected side of her face, owing to a dislike of the very obvious nature of the deformity.

return of their trouble—viz., exposure to cold chills, sudden bright lights, mental worry, and insufficient or unwise food.

RESTORATION OF STENO'S DUCT.

Where, after burns, stabs, ulcerations, sloughing, operations for removal of growths, a most annoying salivary fistula persists, the patient suffering from disagreeable, hot dryness of the mouth, and from constant irritation and inflammation of the soft parts from the dribbling of saliva, where previous measures—*e.g.*, collodion and heated wire, paring the edges—have failed, the surgeon may adopt one of the following measures:

(i.) The following will often succeed in a recent case.

The opening into the mouth is first found, or one in its position made, by passing a fine silver probe from the fistula into the mouth.* As soon as the oral opening is found or established, the probe is passed from the mouth along the duct, beyond the fistula, up to the gland itself. The other end of the probe is then brought out of the angle of the mouth, curved, and secured by strapping on the cheek, while the fistula is kept as dry as possible, and covered with collodion, in the hope that it will close,† now that the oral opening is re-established.

Mr. H. Morris (*Clin. Soc. Trans.*, vol. xiii. p. 144) has recorded a case which he successfully treated on the same lines, but with a fine catgut bougie, which is much more easily worn than a probe. He also suggests that it would be well if, during any operation on the face for removal of a new growth, it be found necessary to divide the duct, a bougie should be passed at once, and the patency of the duct secured.

(ii.) In cases of longer standing, where the duct is more obliterated, especially at its narrow oral end, and the restoration is not so easy, some such operation as Dessault's must be performed. A fine trocar and cannula are pushed through the cheek from the fistula forwards and inwards into the mouth, following, as far as possible, the course of the duct. The trocar being withdrawn, a small silk seton is passed along the cannula; this is then taken out and the two ends of the seton, the one projecting from the mouth and the other from the fistula, are tied together; at about the end of three weeks (according to the amount of inflammation) the seton is withdrawn, and the sinus established by it is kept open by probe or bougie, as already described.

When the patency of the new duct is thoroughly established,‡

* Close to the projection of the mucous membrane, which usually denotes the position of the orifice of the duct, opposite to the second upper molar tooth.

† If this fails, a plastic operation of paring the edges and uniting them with numerous fishing-gut sutures will probably be required.

‡ Sir J. E. Erichsen (*Surg.*, vol. ii. p. 557) suggests the passage of a piece of laminaria tent, if the sinus shows much tendency to close.

the external aperture may be closed by collodion, the cautery, or paring the edges, according to its size.

OPERATIVE TREATMENT OF LUPUS.*

We owe to German surgeons our knowledge that, from the infecting power of lupus growth, it is impossible, when once it is established, to cure it by constitutional treatment. A further step has been the gradual replacing of local treatment with caustics, or the cautery, by the erosion method of Volkmann.†

Lupus is so frequently met with in this country, the deformities which it produces are so odious, and it is so readily arrested by local treatment vigorously applied and energetically repeated, that a few practical remarks will be made on the two chief methods of using it—viz., erosion and scarification.

Mr. J. Hutchinson thus compares the three methods of local treatment (*Brit. Med. Journ.*, May 1, 1880): "All are very good, but I unhesitatingly prefer the last. If caustics are used, they must be used very freely. I have repeatedly seen a patch wholly cured by a single dressing with chloride of zinc or acid nitrate of mercury. As a rule, these remedies are used too timidly or without sufficient painstaking. They give more pain than the actual cautery, but their sores granulate better and heal more quickly. The actual cautery is comparatively painless, can be easily limited, and at the same time made to act deeply. It is very efficient, but its burns are somewhat slow to heal. The erosion treatment appears to give less pain, to be very efficient, and to leave a sore which heals rapidly and soundly."

Before speaking in detail of these methods it will be well to say a few words about the chief forms of lupus, and to which of these erosion or scarification is best suited.

I think that for the purpose of treatment the surgeon should keep two great types before his mind. In one of these the lupus deposit takes the shape of more or less localised nodules, tubercles, or nests, reddish or yellowish pink, often quasi-gelatinous, and prone to attack the cheeks near the junction of the alæ and the upper lip. In the other the lupus deposit is much more diffused, usually, too, more superficial and less inclined to form nodules or nests. This type is met with both on the cheeks and nose, but is best seen on the latter. It is, in my experience, much the most frequently met with form in the surgical wards of a London hospital, and is the one most often responsible for marring the above important feature in young patients, usually girls. This is the lupus seborrhagicus of Prof. Volkmann,‡ the seborrhœa being

* The above account, while introduced here from the greater frequency of lupus on the face, is, of course, applicable to the disease elsewhere.

† *Germ. Clin. Lect.*, Syd. Soc. transl., p. 97.

‡ Prof. Volkmann (*loc. supra cit.*, p. 105) gives the following life-like description of this form: Irregular, reddish-looking patches met with on the cheeks

of secondary importance, the essential point being the fine-cell lupus infiltration of the cutis, which develops most freely in the neighbourhood of the sebaceous glands, in which the cheeks and nose are so rich, and gives rise to an increased secretion on their part.

Erasion.—This is most strongly indicated in both the above forms of lupus, whether localised or diffused. The best instruments are sharp spoons, with oval ends of varying size, or hoes; whatever instrument is used should be of steel, the silver scoops supplied in dressing-cases being inefficient. Where the lupus deposit is of any size it should be deliberately and thoroughly scraped out, the instrument being carried most painstakingly both over the surface and around the edges. Where the deposits are more minute they must be as carefully picked out. The surgeon need not fear removing too much, as long as he keeps to parts which yield to a scoop which will never remove sound, and only with difficulty, partly sound, tissues.*

Scarification.—This is only useful in the more diffuse forms, and is to be employed in two ways. (a) Linear. With a fine and very sharp scalpel the surgeon makes scores of fine delicate cuts, parallel with each other, through the diffuse lupoid deposit crossing these again with similar delicate incisions at a right angle the first.† All these must be made quickly and with a light hand, and care must be taken, as far as possible, not to let them run into each other. The bleeding is extremely free, but is readily arrested by carefully maintained pressure.

(b) Punctiform. Here hundreds, maybe, of punctures are made in the diffused lupoid deposit, a delicate hand being again required, and a fine sharp scalpel-point or a large needle being used. In this case, also, every pains must be taken to place the punctures equidistantly. After arresting the bleeding the sur-

and nose, often covered with "dirty-looking, thin crusts, which are distinctly fatty to the touch. They consist, in fact, of nothing further than an excessive secretion from the sebaceous glands of the skin mixed with epidermis cells. When we have succeeded, with great difficulty, in scraping off this fatty layer with the knife, the underlying skin appears red, sore, and as if studded with fine warts. But if you examine these warty points more closely with a glass, you see that it is by no means a question of papillary elevations, but of a large number of fine holes, which, being closely adjacent to each other, produce the warty appearance. These holes are the enlarged openings of the sebaceous ducts, and you can also see on peeling off single fatty crusts how a fine prolongation of the latter becomes detached from each small opening."

* As pointed out by Prof. Volkmann (*loc. supra cit.*, p. 114) in cases of lupoid ulcerations of longer standing, an almost fibroid tissue becomes exposed after the diseased parts have been scraped off, a condition which is to be regarded as the expression of reaction in the neighbourhood.

† No scarring need be feared from either form of scarification. After three weeks have elapsed the above incisions, however numerous, if done with proper delicacy, can only be detected by looking for them very closely. In three months it usually requires a lens to find them.

geon looks carefully over the patch; if at any spots his incisions or punctures are crowded together with intervening places but little touched, he again goes over the ground carefully.

If, after the completion of these operations, the tissues appear tallowy or whitish, there need be no fear of gangrene, the parts being far too well supplied with blood. Prof. Volkmann, after using the above methods, wipes the parts over with a stick of silver nitrate, and applies dry lint.

An anæsthetic should invariably be given.* Repetitions are usually required in severe cases, two or three times at intervals of three weeks or more, or whenever minute reddish specks appear and grow around the original disease, or when the scar, though not again ulcerating, remains obstinately dark bluish-red.

The object of scarification is, of course, to obliterate the lupoid deposit by the formation of scar-tissue.

Where the nose is affected, the inner aspect of the orifices should be examined in case the mucous membrane is invaded.

After an operation for lupus the patient should be seen at intervals of three months, and any recurrence destroyed while small by the sharp spoon, or, much better, if occurring in scar tissue, by a fine point of the thermo-cautery (a very useful form of this on a small scale is sold by Hawksley, 357 Oxford Street), or by the acid mercury nitrate.

OPERATIVE TREATMENT OF RODENT ULCER.

Owing to the great frequency of this disease on the face, the following remarks are inserted here :

Some Points of Practical Importance.

i. **Propriety of Operation.**—In this form of malignant disease, owing to its extremely slow progress, its very long connection with some well-known flat-topped wart, patients sometimes keep on deferring the operation till their age and the extent of the ulcer cause some difficulty in urging or advising an operation.

The following may help in forming a decision: (1) The extent, depth, and site of the ulcer. A case of moderate severity—say of the size of half a crown—may nearly always be submitted to operation. But the difficulty of deciding will be much greater in cases which involve extensively the nose, orbit, and eye, perhaps, especially if the bones on the delicate inner wall are much involved; in the rarer cases in which orbit, nose, and mouth, are thrown into one hideous chasm,* and those cases, also rare, in

* Dr. Balmanno Squire recommends (*Brit. Med. Journ.*, May 1, 1880) the freezing the skin with ether spray. This so entirely alters the feel of parts that I have not used it. Cocaine may perhaps be useful in the lighter cases. For rendering scarification expeditious and precise Dr. Squire has devised a multiple linear scarifier. This instrument (Weiss) is most useful in port-wine stains, though I prefer fine, very keen scalpels, which will suffice both for linear and punctiform scarification.

† As in Figs. 2 to 6 at the end of Mr. Moore's work on *Rodent Ulcer*.

which the ulceration extends very widely, though superficially, involving forehead, temple, and parotid region.* (2) In all cases of severity the following should be carefully considered—viz., the real age † of the patient—*i.e.*, the age not reckoned by years alone—his habits, how long he probably will live if no operation is performed; whether the disfigurement seriously interferes with the following of an active life; whether there have been any brain symptoms referable to the growth; the condition of the viscera; any liability to erysipelas; finally each case being considered by itself, certain conditions will justify operations in otherwise doubtful cases, as when a rodent ulcer, having destroyed the sight of one eye, is creeping across the nose and threatening the opposite one.

ii. **The Operation Itself.**—In these days of aseptic surgery, the combined operation by knife and caustics, or cautery, will be preferred to one by caustics alone, on account of its greater precision, and more rapid and more painless healing, the absence of fetid sloughs, and the diminished liability to erysipelas, &c. The following hints may be found useful in an extensive operation:

(1) To diminish the risks of erysipelas in these patients the parts should be carefully cleansed and kept as aseptic as possible by means of precautions similar to those given at p. 243.

(2) Steps of the operation itself and the application of caustics.—The surgeon first makes a groove-like incision ‡ around the whole, or, in a very extensive case, around part of the growth,

* Mr. Moore (*loc. supra cit.*, Fig. 9) shows one of these superficial but vast rodent ulcers; and his cases vi. and vii. show the exceeding difficulty, if not impossibility, of completely curing them, even in hands as experienced as his. He thought (p. 58) that the firmness of the skull presented a mechanical obstacle to the complete healing of these large sores. Mr. Hutchinson (*Clin. Surg.*, vol. ii. pl. 65) points out that this extensive form may be very superficial for a long time, may even cicatrise with tolerable soundness, but that, sooner or later, a stage of deep growth and rapid progress is almost certain.

† Sir James Paget's words on the risks of operations in old people (*Clin. Lect.*, p. 6) may be quoted here: "They that are fat and bloated, pale with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not indeed good subjects for operations, yet they are scarcely bad. The old people that are thin and dry and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble and soft-skinned, with little pulses, bad appetites, and weak digestive power, so that they cannot, in an emergency, be well nourished." Sir James goes on to speak of their inability to bear loss of blood, the lazy healing of large wounds, the liability of their stomachs to refuse food, their prolonged convalescence, their getting "all but well," and the need of meeting these special dangers with special cares.

‡ A pair of sharp blunt-pointed scissors may be found useful when the lids have to be cut through.

and well wide of it, and arrests the bleeding by ligature, leaving on Spencer Wells' forceps, or by sponge-pressure. The next step—that of removing the affected soft parts—is often difficult, owing to their proneness to break away, and thus giving no firm hold to forceps; a sharp spoon is often very useful here, but scraping alone is not to be trusted to. Having scraped away the growth down to tissues apparently healthy, the surgeon scrutinises these most carefully, picking out every atom of yellow-grey granulation-like material, and then again repeating the scraping with careful thoroughness. Where the bones themselves appear eaten into, scraping will not be sufficient, and it will be wiser to go over the worm-eaten surface with a fine gouge or chisel.* In one region especially these must be used with the utmost caution—*i.e.* where the paper-like bones on the inner wall of the orbit are involved; in this place, if the surgeon is not satisfied with the limited use of the gouge or chisel—which is alone permissible here—he must be content with finally applying Paquelin's thermo-cautery (p. 271), unless removal of the eye, at the same time, has allowed of the use of zinc-chloride paste. In other places this most valuable caustic may be used fearlessly, as long as precautions are taken to use it in a concentrated form, and to apply it in a thick state and as little of it as possible, so that the discharges from the wound shall not allow it to liquefy and run either towards the eye or nose or throat.

(3) Question of removing the eye in cases where the conjunctiva is involved. As a rule, consent should be obtained for this step if needful. Cases clearly requiring it will be those where (a) the eye is already useless, or so distinctly deteriorated that it cannot improve; (β) where the lids have shrunk off away from it, and left it irritable and painful from exposure; (γ) where the disease cannot otherwise be removed or caustics be made use of.

As a rule, if the conjunctiva is much involved, the necessary removal of this will cause sloughing. Occasionally, this only threatens, and then passes away.

Six years ago a patient of Drs. T. and J. B. Howell, at Wandsworth, came under my care for extensive rodent ulcer. Both lids of the right eye, the conjunctiva largely, the inner part of the orbit, root and right side of the nose, and upper part of right cheek were involved. Operation had been advised ten years before. After removal of the soft parts involved by the growth, it was found that the lachrymal and ethmoid were much involved, being very vascular and worm-eaten. Repeated applications of the sharp spoon and the small gouge were made use of, and finally Paquelin's thermo-cautery was applied. The inner half of the conjunctiva was involved, and removed freely, the internal rectus being exposed. The cornea became cloudy and discoloured, and though on the third day the pupil was visible and the patient could distinguish between the

* Mr. Moore (*loc. supra cit.*, p. 51) speaks decisively on this point: "The bone itself must be taken away to a depth exceeding that which has yielded to the disease. Recurrence is otherwise inevitable."

medical men at his bedside, the cornea ultimately sloughed, and I removed the eyeball a few weeks later.*

iii. **The After-Treatment.**—(1) The chief object here is to keep the wound scrupulously sweet. I prefer for this gently packing the wound with iodoform gauze, or, in cases where erysipelas may be expected, dusting with iodoform, and dressing with boracic-acid lint soaked in a saturated solution of the acid, and changed at regular intervals. Sufficient morphia should be given for the first day or two, and the bowels kept regularly open. If zinc-chloride paste has been used, attention must be paid, as already advised, that it does not melt and run into parts like the eye, nose, or mouth, and for this same purpose the position of the patient's head must be looked to. The gauze or lint on which it is applied should be removed at an interval of a few hours according to the depth which the original disease has reached. (2) If it has been found needful to attack vigorously the bones of the skull, or even to apply some of the caustic to diseased dura mater, and if during the first ten days of the disease fits make their appearance, it does not necessarily follow that cerebral inflammation is setting in. According to Mr. Moore the fits may be slight and the unconsciousness of brief duration, or the fits even severe and attended with coma, but, as a rule, they are recovered from. (3) Secondary hæmorrhage. This is rare after the use of zinc chloride, which forms deep, tenacious, black sloughs, and also seems to me to prevent the risk of pyæmia. But if the cautery only has been used, the amount of fœtor is much greater, and in parts so vascular secondary hæmorrhage may easily occur, if the wound is foul. (4) Recurrence. The patient must always be most carefully watched, and, in the case of extensive and deep disease, any suspicious granulations that appear must be attacked at once. (5) After a severe operation a plastic operation—*e.g.*, the bringing down of a flap from the forehead, should be performed, and this failing, much may be done by a well-made vulcanite mask.†

REMOVAL OF PAROTID GROWTHS.

The question of operation arises here under three somewhat different conditions—viz. :

- (i.) In the case of the ordinary parotid tumour.
- (ii.) In that of a sarcoma of the parotid, which has often started in the growth just mentioned.

* It would certainly have been wiser to have removed the eye at the first operation, a step which would have facilitated the use of zinc-chloride paste. The patient, however, had so much difficulty in making up his mind to be operated on, that it was thought best to attempt to do without the additional mutilation if possible. He remains well.

† As is shown in Figs. 6 and 7 in Mr. Moore's book, *loc. supra cit.*

(iii.) In carcinoma of the parotid.

(i.) **Removal of an Ordinary Parotid Tumour.**—These well-known growths, containing a mixture usually of fibro-cartilaginous, myxomatous, and imperfect glandular tissue require no especial allusion here, beyond the need of—(1) Exposing them sufficiently, (2) Paying strict attention to the facial nerve, and (3) Removing the capsule itself, after the growth has been shelled out, in any cases of doubt—viz., soft consistency, or rapid growth.*

(ii.) **Operation in Sarcoma of the Parotid.**—This disease usually begins in one of the growths just mentioned. This and the next group may, as far as operations go, be considered together.


(iii.) **Operation in Carcinoma of the Parotid.**—The question of the advisability of interfering at all with really malignant growths of the parotid, especially carcinomata, has been much disputed, but as each case must be decided by itself, and as no hard-and-fast line can be laid down here, some useful practical points may be mentioned. On the one hand, attention must be strongly drawn to the fact that reports of operations here are often brief, and that too often they are published as soon as the patient leaves his surgeon, and thus two-thirds of their value are lost; on the other hand, I may perhaps remind my younger readers that a malignant tumour in this region is one in which, above most others, he must not allow a wish to relieve a patient to overcome a decision arrived at after careful examination, for there is scarcely any part of the body in which a malignant growth so quickly obtains a firm hold on the surrounding structures—a fact which has even a graver bearing on the operation than the importance of these structures themselves.

Practical Points in the Removal of Parotid Tumours.

Characters of the Tumour.—Amongst the most notable of these are—(1) Mobility—viz., how far it can or cannot be lifted up by the fingers from the subjacent parts. (2) Rapidity of growth. (3) Density—thus a great hardness or evident softness will be, alike, unfavourable, the latter from the fact that such soft growths will break down during attempts at removal, and leave part behind. (4) Pressure symptoms. Of these, dyspnœa, dysphagia,

* In an article (*Guy's Hosp. Reports*, vol. xxvi.) "On the Enchondromata of the Salivary Glands," I wrote, with regard to the removal of these growths, "if the wound be made too small in the first case for fear of a scar, the edges will only be bruised and primary union prevented. It is not uncommon for branches of the facial nerve to be in relation with the capsule of the tumour, and if this has been much handled, or treated by counter-irritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself."

presence of outlying masses in the fauces, and facial paralysis* are of evil omen. (5) Condition of the overlying skin.†

Points in the Operation itself.—To begin with, the growth must be sufficiently exposed by adequate incisions. Probably none will be more generally suitable than a  shaped incision, the vertical portion lying over the large vessels, and the transverse one exposing the facial part of the growth.

If the skin is adherent at any spot this should be removed at the same time. The growth being sufficiently exposed, the extirpation of it had best be begun in front and above,‡ the posterior part being left to the last, as here lie the most important relations, and as these can be most readily dealt with when the growth has been freed elsewhere. During the operation a blunt dissector should be used as much as possible, aided by touches of a pair of scissors, and by dragging the growth in different directions. Every vessel, as soon as cut, should be secured with Spencer Wells' forceps, and the free oozing from the vascular skin and other parts arrested by sponge pressure while the surgeon is engaged with some other part of the growth.

In addition to the free oozing, and the presence of important vessels, other difficulties which may present themselves are the breaking down of a soft growth, thus baffling attempts at complete extirpation, and the strong processes of fibrous tissue which, passing normally from the parotid to some important adjacent structures—viz., the digastric, the internal pterygoid, and the carotid sheath—are now liable to be either increased in density, or softened by extension of the growth.

Two points require especial attention here—viz., the amount of facial paralysis which may be expected,§ and the hæmorrhage.

Facial Paralysis.—While in the case of a smaller growth, if the nerve has only been bruised, or, when divided, if the ends have been placed in contiguity, union may take place, and the paralysis

* Prof. Billroth, quoted by Mr. Butlin (*loc. supra cit.*, p. 118), considers that facial paralysis from the pressure of a parotid tumour is a sign that this is probably a carcinoma, for the sarcomata and other tumours rarely produce paralysis by pressure, although paralysis frequently follows the operation for their removal.

† The more adherent, discoloured—viz., reddish purple—are the integuments, the more unfavourable is the prognosis.

‡ M. Bérard (*Maladies de la Gland parotide*, p. 240) advises that after the growth has been freed in front, it should be next attacked from below upwards, and not from above downwards, for these reasons—(1) The blood flows away from the wound, and not over the instruments of the surgeon; (2) the same vessels do not have to be tied more than once; (3) if any large vessel has to be cut, it is secured early, thus diminishing the amount of hæmorrhage.

§ If the surgeon, especially in less serious cases, when making any deep incision that is needful, can manage not to go above the level of a line drawn horizontally $\frac{3}{4}$ inch below the lobule of the ear, he will avoid any serious interference with the trunk of the facial nerve, and thus escape the risk of permanent paralysis.

gradually disappear,* in the case of really malignant growths the question of future deformity must be set aside, and the nerve divided as soon as seen.

Best Modes of Meeting Hæmorrhage.—The chief vessels which will be met with are, the superficial temporal, transverse facial, occipital, posterior auricular, the internal maxillary, and external carotid. The external jugular vein, and large communicating branches between it and the internal jugular are sure to be cut, while the internal jugular vein is almost certain to be seen in the bottom of the wound.

It must be remembered that not only will all the above vessels be liable to be much enlarged, but numerous other unnamed anastomoses will be present.

The common carotid has several times been tied prior to this operation. With all due deference to those who have adopted this practice, I would advise that this step should be dispensed with if possible, and for these reasons—(1) It introduces certain grave additional risks of its own. (2) It takes up time which will be wanted in the operation itself, especially if the projection downwards of the growth into the neck overlaps and conceals the position of the vessel. (3) It is by no means a certain preventive of hæmorrhage here, any more than ligature of both linguals can always be relied on to prevent hæmorrhage during extirpation of the tongue. (4) This step, recommended by many of the older surgeons, is not so needed now in these days of anæsthetics, with an almost unlimited variety of forceps and ligatures at hand. (5) Finally, it would appear better, because simpler and equally efficient, to meet the hæmorrhage from the large vessels before they are cut, by taking them up with two pairs of Spencer Wells' forceps, dividing the vessel between these, and tying or twisting both ends.

In dealing with any large veins the risk of the entrance of air should be prevented by making finger-pressure on the cardiac side, or by securing them with double ligatures before they are cut.

If ligature of the common carotid is to be made use of here, it should, in my opinion, be reserved for those cases in which the surgeon decides to attack a very soft and vascular growth, as here the vessels may be very numerous and difficult to isolate, and ligatures may not hold. In such a case, instead of tying the common carotid and thus exposing the patient to the risks of brain mischief, it would be better to pass a loop of chromic catgut ligature around the vessel, loosely tied, and to ask an assistant to keep up tension on this whenever bleeding takes place. This method seems to have been first used by M. Roux, and of late by Mr. Rivington (*Med.-Chir. Trans.*, vol. lxi. p. 72) and

* This gradual improvement is alluded to, with a case in point, in my article, *loc. supra cit.* Mr. Butlin (*loc. supra cit.*, p. 120) suggests a trial of nerve-suture here.

Mr. Treves (*Lancet*, January 21, 1888). See Section on "Ligature of Common Carotid."

If the wound has become foul—and sometimes in these operations near the mouth and nose it is impossible to keep the bandages from shifting—the surgeon must always be prepared for the accident of secondary hæmorrhage. And on account of the same risk the actual cautery should never be used at the bottom of a very deep wound near to any suspicious tissues, if it can be possibly avoided. If some caustic is required, zinc-chloride paste, used with the precautions given at p. 273, would, I think, be preferable from the absence of foetor with which it works, and the dry black scabs it forms.

OPERATIVE TREATMENT OF NÆVI.*

The first question which usually arises is whether these growths should be operated on at all, or whether they may be safely left to themselves. While there is a distinct tendency for nævi, after a term of life, to undergo fibro-cystic change, I doubt if this tendency to spontaneous disappearance is as high as Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 702) puts it—viz., that "certainly more than half are thus naturally cured." In private practice, where a nævus is not extending, where it is in neither a dangerous nor a conspicuous place, it is justifiable to watch the nævus, remembering that the times of teething and of puberty may bring about atrophy or increase, and that the former, while often spontaneous, is most likely to follow one of the exanthemata. But when a nævus occupies a dangerous site, one where irritation of any kind is likely to bring about hæmorrhage, *e.g.*, scalp, lips, tongue, palate, genitals, rectum, fingers, or toes, or where the site is a conspicuous one, no time should be lost in effecting a cure.

While admitting that there is a distinct tendency for a nævus to degenerate ultimately, I should advise operative treatment in nearly all cases for the following reasons:—(1) During its growing and stationary stage the nævus is always a source of anxiety and often of disfigurement. (2) In hospital practice there is the greatest difficulty in persuading the mother to put up with any deformity that is remediable in her child. (3) In early life nævi are usually small, and easily and safely cured. (4) The spontaneous cure of a large nævus may leave, by much puckering of the skin, more deformity than that of an operation. Before describing the different operative measures I would remind my younger readers (a) that there is no method suited to all cases; (β) that it is very easy, by using heroic means and doing too much, to cause needless scarring; (γ) that during the cure of large nævi

* I have spoken of their treatment now for convenience' sake, and because of their great importance on the face.

in early life the patients are liable to pyrexial attacks and grave malaise.

Different Methods.

1. *Collodion*.—This may be tried in tiny cutaneous nævi. These can, however, be better treated otherwise. In all other nævi it is a harmless placebo. (2) *Vaccination*.—This is not to be recommended. From a very large number of cases which I have seen where this has been used, I am of opinion that it very rarely cures the nævus, while the vaccination is not reliable. (3) *Subcutaneous Discission*.—This is an excellent means of obliterating a nævus without scarring, introduced by Dr. Marshall Hall. A cataract-needle is passed from a point about a line from the margin of the nævus to the opposite extreme edge of the growth. The needle is then withdrawn almost to its point of entrance, and pushed again through the nævus at about $\frac{1}{16}$ inch from the line of the first puncture, and so on till the lines of puncture take a fan-like shape. Should the needle penetrate the skin, pressure must be applied. This method is best adapted to subcutaneous or mixed nævi of moderate size. After a few weeks repetition may be needful. (4) *Nitric Acid*.—This is useful in cutaneous nævi. The parts around should be smeared with vaseline, but neither the pointed wood nor glass rod should carry enough to run any risk of damaging the adjacent skin. Careless use of the acid may produce most odious scars. (5) *Sodium Ethylate*.—This is useful in cutaneous or mainly cutaneous nævi. It is efficient, not very painful, though accompanied with a good deal of tingling, and its scars, if it be carefully used, are little conspicuous. If some aseptic wool is secured with collodion over the eschar, this separates without suppuration. Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 707) thinks this escharotic most suited for those cutaneous nævi where the centre has become obliterated and the margin remains. (8) *Electrolysis*.—This method has the advantage of leaving a minimum of scar or pucker behind it. The disadvantages are that it requires several sittings—on an average, four or five—and, as an interval of six weeks should elapse between each, the treatment is spread over a considerable time. For this reason the method is not suited to hospital patients, who are ill content if the blemish is not speedily removed. Electrolysis is best suited to those nævi which are subcutaneous and easily got at—though for the majority of these I prefer excision—and for those nævi which are unsuited to excision, and where the cautery will leave a conspicuous scar upon the eyelids and nose. Dr. Newman (*Brit. Med. Journ.*, 1882, vol. ii. p. 248) writes: “The cases for which electrolysis is eminently suited are superficial, dark-coloured, sluggish, vascular growths, which do not possess special or abundant blood-supply. They waste away after one or two sittings as a matter of moral certainty. Next in order are those nævi which, agreeing with the above in their actual vascularity, yet have much more of surface covering, and which do not, there-

fore, so readily declare the conditions of their blood-supply. A majority of these cases will probably be found to be quite amenable to the electric current. On the other hand, the cases in which electrolysis will not, at least as a rule, succeed, are those which are intensely vascular, which are rapidly growing, and which it is fair to conclude have more or less direct communication with blood-vessels." Dr. J. Duncan (*loc. supra cit.*) thus describes the method which he has done so much to improve: "Practically, in electrolysis a naevus we introduce subcutaneously so much caustic potash and nitric acid made out of the tissues on the spot. We introduce them in such infinitely minute division, and we so destroy tissue in producing them, that their action is purely local and they cannot be carried into the circulation, while the small quantity produced is yet extremely potent, because it is nascent. By doing this subcutaneously we avoid the evils of putrefaction and we conserve the skin. . . . After trying many batteries of constant current, I have reverted to the Bunsen or Smee, with four to six cells of large size. In the Infirmary, where it can be prepared by others, I use the Bunsen of four cells, as giving the largest amount of chemical work with the least tension. But in private, Smee's battery with plates about 4 inches by 6, and having six cells is most convenient. It is less dirty, has only one fluid, and is equally effective." Before operating, the poles should be tested in saline water, and only used if the evolution of gas is copious and continuous.

The needles recommended are those introduced by Prof. Fraser and Dr. Duncan. They should be insulated with vulcanite. The length of the exposed point should vary from $\frac{1}{8}$ to $\frac{3}{4}$ inch, according to the size of the naevus. Steel is the best material; but the positive pole, if of steel, requires re-sharpening after each operation, because it is acted on electrolytically. Both poles should be introduced, as giving most work in the least time. In small naevi they are best placed parallel, and equidistant from each other and from the sides of the tumour. In large naevi Dr. Duncan moves them, especially the negative, from place to place, and introduces them through new punctures. If left stationary, the action rapidly diminishes after ten or fifteen minutes, on account of the slough with which they surround themselves. It is necessary to watch very closely the growing induration round each needle. It increases slightly even after the needles are withdrawn, and the action must be stopped before the skin is involved. If the needles be very slowly withdrawn while the battery is still working, so as to cauterise slightly their track, not a single drop of blood will flow, otherwise pressure should be applied for a few minutes. The naevi should then be covered with aseptic wool and collodion. In large naevi too much must not be done at one sitting or in one place. The slough has to be absorbed, and it is better to establish several small sloughs at different parts than a great mass at one. An anæsthetic is required even in adults.

(9) *Excision*.—I use this method very largely for nearly all subcutaneous and mixed nævi save those on the face, and for many large cutaneous ones where the scar will be hidden. There is a very great probability of primary union; it is a rapid method, leaving no slough to separate as does the ligature, and needing no repetition as in electrolysis. Two points require notice; one is the risk of hæmorrhage. This is met by working rapidly, by judiciously applied finger-pressure, by keeping wide of the nævus, and, where the bleeding will be severe, by using the method of Mr. Davies-Colley. My colleague passes two needles, at right angles to each other, beneath the base of the nævus, and twists around and below them a fine drainage-tube; below all, two or three silver sutures are passed deeply. After the nævus is removed, the needles and drainage-tube are withdrawn, and, before bleeding can occur, the sutures are quickly twisted up. The other point is the advisability of leaving any nævoid skin in the excision of a large mixed nævus. While the greater part of the diseased skin should always be removed, narrow strips left on either side will, usually, slowly take on a natural colour. In excision irrigation with hot perchloride solution, 1 in 4000, should be made use of, drainage with horsehair employed, and the wound carefully united with sutures of fishing-gut and horsehair or wire which can be quickly twisted when the hæmorrhage is free.

(10) *Cautery*.—Paquelin's cautery is usually employed, the large blade at a red heat being carefully wiped over a cutaneous nævus, and the fine point used for the subcutaneous ones. This is made to penetrate the skin at one spot, and then made to traverse the nævus in several directions from the one puncture. It is most effectual, but the more I see of it the less I like it, owing to the large scars it leaves. Thus the black sinus or sinuses left after the operation with a red margin of scorched skin suppurate and heal tediously, and with much disfigurement in exposed places. The modified Paquelin's cautery, mentioned at p. 271, is greatly to be preferred to that in ordinary use, or a cautery battery and the fine platinum points which any electrician can supply. If, in hospital practice, the surgeon arranges for his nævi cases to attend on one day, there should be no difficulty about the battery being ready. The amount of scarring left is far less than that by the Paquelin's cautery. No anæsthetic is required with either in infants, the pain being momentary. A very simple form of cautery for those stellate patches which appear on girls' faces long after infancy is supplied by a needle heated or dipped in nitric acid. An anæsthetic should be given. Another excellent means for healing minute nævi is to make a puncture with a tenotome, and apply for a few seconds a finely pointed stick of silver nitrate.

(11) *Ligature*.—I have long entirely abandoned this, owing to its painfulness, its production of a slough and large scar, and the risk there is that parts of the strangled mass are very apt to escape obliteration. (12) *Injection*.—This, as usually performed with an

iron preparation, is extremely risky, and should never be made use of unless the nævus is securely surrounded, as with a ring-forceps. Several cases fatal from thrombosis and embolism have been recorded (*Lancet*, 1867, vol. ii. p. 191). I remember witnessing one in my student days. The late Mr. W. M. Coates, a surgeon of wide experience, used iodine injection with much success (*Brit. Med. Journ.*, 1883, vol. ii. p. 319). About $\frac{1}{2}$ drachm of the undiluted tincture is thrown in slowly by means of a Wood's syringe with a very fine needle. By moving the point, the tincture is thrown into every part. On withdrawing the needle, pressure on the puncture is required for a few moments. The nævus hardens at once and slowly disappears. No scarring results. Mr. Coates considered the iodine quite free from any risks of thrombosis.

CHAPTER V.

EXCISION OF THE EYEBALL.

EXCISION OF EYEBALL.*

Indications.

i. New growths—*e.g.*, glioma of the retina, melanotic sarcoma of the uveal tract.

ii. In the following cases of injury and its results :

(a) The eyeball ruptured and collapsed after a blow.

(b) A large, jagged, foreign body in the eye—*e.g.*, a bit of metal, not removable without inevitable disorganisation.

(c) If (Nettleship's *Diseases of the Eye*, p. 142) the wound, lying wholly or partly in the dangerous region,† be so large and so complicated with injury to deeper parts that no hope of useful sight remains.

(d) If, though the wound be small, it lie in the dangerous region, and have already set up irido-cyclitis.

(e) Where a small foreign body—*e.g.*, a shot glancing in cover-shooting—not removable by an electro-magnet, gradually sets up inflammation and shrinking of the eye.

(f) When there is a wound in the dangerous region complicated with traumatic cataract.

(g) When traumatic cataract has been set up by a wound which is wholly corneal, and therefore out of the dangerous area, and yet severe iritis and pan-ophthalmitis come on in spite of treatment.

iii. As part of an operation for rodent ulcer which has extensively involved the conjunctiva (p. 273).

iv. As part of an operation for removal of orbital tumours—*e.g.*, a glioma or sarcoma which has ruptured the sclerotic, rodent ulcer, scirrhus, sarcomatous, bony growths, &c.‡

Operation.—The chief object is to remove the globe alone, whenever this is possible, leaving the muscles to coalesce and form

* As the general surgeon may be called upon to perform this operation at any time, and as it should always be practised on the dead body, it is included here.

† A zone nearly $\frac{1}{4}$ inch wide surrounding the cornea.

‡ For an excellent account of these the reader is referred to Mr. Lawson's article, *Dict. of Surg.*, vol. ii. p. 117 *et seq.*

a stump on which the artificial eye may be supported and be movable. As much conjunctiva as possible should be left.

The surgeon, standing in front, having inserted a spring speculum between the lids, snips with blunt-pointed scissors through the ocular conjunctiva close to the cornea and all round it, using toothed forceps to lift the conjunctiva, and leaving enough at one side to hold on by the forceps during the next step. This is to open freely Tenon's capsule, and catching up each rectus tendon (beginning usually with the external rectus) with a strabismus hook to divide them close to the sclerotic, leaving the cut end of the external rectus long, in order to draw the eyeball forcibly inwards. The superior and inferior rectus are then cut, and the speculum pressed back into the cavity of the orbit so as to make the eyeball start forwards. The scissors, blunt-pointed and slightly curved, are now passed back to feel for the optic nerve, which may be known by its toughness and thickness, and which is now severed with one clean cut. The eyeball being drawn forwards with a finger, the oblique muscles and any remaining soft parts are to be cut close to the globe. Sponge-pressure is then to be applied firmly for a few minutes, and for the first ten hours aseptic sponges and a bandage should be worn to prevent temporary but troublesome hæmorrhage.

In the case of a new growth—*e.g.*, glioma—the optic nerve must be divided as far back as possible. The scissors, slightly curved and long enough to reach to the back of the orbit, are introduced on the inner side, and the nerve either cut as far back as is possible before the globe is removed, or, after this is done, the nerve is dissected out and a fresh slice taken.

Where there is any suspicion of growth, as in a glioma of the optic nerve, being left behind, zinc-chloride paste should be applied. as at p. 273.

Owing to the early stage at which dissemination of intra-ocular sarcomata takes place, and to the tendency of gliomata to creep backwards along the optic nerve towards the interior of the cranium, the prognosis very largely depends upon the earliness of the extirpation. On this account it should be remembered that the earliest symptoms of these growths—*viz.*, impairment of sight from partial detachment of the retina by the pressure of the growth behind it—should be most carefully tested in suspicious cases, this impairment of sight being not usually noticed by the patient, save accidentally on closing the sound eye, unless the growth originates near the yellow spot. If later evidence is waited for, such as evidence of tension and pain, dissemination or recurrence is most probable, while the growth will very likely have perforated the eye, and the severer operation of clearing out the orbit will be required.

The following questions will very likely arise: If there is evidence of general dissemination of the disease, is it expedient to remove the eye, or, if this be insufficient, to clear out the orbit as well? In most cases the answer will be in the affirmative, in order

to save the patient pain, and the misery of the protruding and ulcerating mass.

If the disease has recurred, is it any use to again attack it? Each question here must be decided by itself. The answer will mainly depend on the amount and depth of the recurrence, and on the completeness of the first operation. Thus, if the eye only was removed at first, it may be wise to clear out the orbit thoroughly.

In a few most distressing cases in children it is well known that both eyes are attacked. The question of operating on the second eye must now be faced. Opinions here differ somewhat. Mr. Butlin* thinks that it is better not to operate in such cases, "although the operation may be regarded as justifiable in order to prevent the occurrence of fungous protrusion and the pain and misery which are associated with it." Mr. Lawson,† on the other hand, holds that if both eyes are affected, both should be excised, providing that the sight has already been destroyed. He has, on many occasions, removed the second eye to procure temporary relief from the excessive pain induced by the over-distended globe, and when there has not been the slightest prospect of curing the disease. In each case the operation gave immediate and perfect relief.

* *Loc. supra cit.* p. 88.

† *Dict. of Surg.*, vol. ii. p. 124.

CHAPTER VI.

OPERATIONS ON THE NOSE.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE — ROUGE'S OPERATION — REMOVAL OF NASAL POLYPI—ADENOIDS OF NASO-PHARYNX.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE (Figs. 84 to 91).

THESE operations may be divided into those for complete and partial restoration.

Indications.—When the patient is healthy and fairly young, when the cause of the destruction—viz., lupus, gunshot injury, syphilitic ulceration, new growth necessitating removal—is not only checked but soundly healed.*

Thus, after lupus has been cured by scraping, and still more in the case of syphilitic ulceration, it will be well to wait six months at least after the disappearance of the disease.

A. Operations for Complete Restoration.—The following will be found the most useful:—

- (1) Verneuil's, by Super-imposed or Double Flaps from Cheeks and Forehead (Figs. 84, 85).
- (2) Syme's from the Cheeks (Figs. 86, 87).
- (3) The Indian or Frontal (Fig. 88).
- (4) The Italian or Tagliacotian.

Before deciding which operation he will make use of in restoring the nose the surgeon will investigate the following points: How far is the bony framework of the nose destroyed? If the cartilages, septum, vomer, ethmoid, and nasal bones are much removed, however well made the frontal flap, and however skilfully it is adjusted, it will tend, after looking extremely well at first, to sink down to the level of the cheeks. Verneuil's operation meets this partially by its double layers of flaps. If he proposes to take flaps from the cheeks, the surgeon must examine how far these are plentiful, and free from old scars. So, too, if the forehead is to

* In Sir W. Mac Cormac's case, quoted below, the tip and alae of the nose had sloughed in infancy after the injection of a large naevus with the liquor ferri pernitratis.

furnish the flaps, how far is it a capacious one and free from hairs?

The respective advantages of, and the indications for, the above operations will be given in the description of each method.

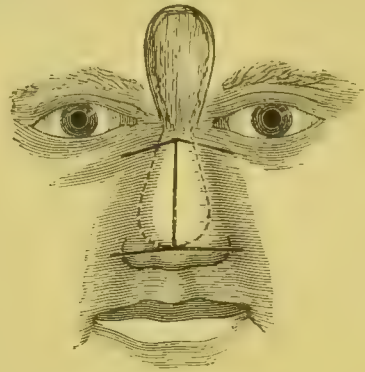
(1) **Verneuil's Operation** (Figs. 84 and 85).—This operation, suggested to M. Verneuil by M. Ollier, was employed successfully by him in order to secure permanent elevation of a sunken nose, by super-imposing two flaps and thereby doubling the thickness. The patient had discharged a pistol into his mouth, destroying a portion of the hard palate and septum, the nasal bones, part of

FIG. 84.



Verneuil's incisions in rhinoplasty for sunken nose. (Stimson.)

FIG. 85.



Verneuil's double flaps *in situ*. The frontal flap is also shown with its raw surface. (Stimson.)

the nasal processes of the superior maxillary, the spine of the frontal, and the anterior wall of the frontal sinuses. The alæ and tip were uninjured, but much flattened; above them was a broad, deep groove, extending to the middle third of the forehead. The principal indication was to rebuild the bridge of the nose. The latter could be permanently accomplished only by filling in the great cavity which would be left by raising the sunken parts.

Verneuil made an incision along the median line of the depression and a transverse one at each end of the first, and dissected up the two lateral flaps thus marked out. He then raised an oblong flap from the middle of the forehead, leaving it adherent between the eyebrows, and turned it directly downwards so that its raw surface was directed outwards, its skin surface* looking towards the nasal fossæ. The two lateral flaps were then placed upon it and united in the median line. The raw surfaces united with each other, and the result was a nose elevated $\frac{1}{3}$ inch above the adjoining surface. The wound in the forehead is partly

* This should be refreshed. The above account is taken from Stimson's *Operative Surgery*, p. 244.

closed by a hare-lip pin and sutures, and later on healed by skin-grafting. The pedicle of the frontal flap will require dividing and trimming subsequently. In addition to the advantage which this operation possesses of rendering a sunken nose prominent, it produces ultimately, from my experience in one case, but little scarring, the lateral incision-scars fading away gradually into the naso-labial sulci, and the folds beneath the eye.

(2) **Syme's, from the Cheeks** (Figs. 86, 87).—This method is described by its inventor in his *Observations in Clinical Surgery*, p. 56. Besides doing away with a frontal scar, this method enables a nose thus constructed to have its sensations in correspondence with the part from which it was derived.

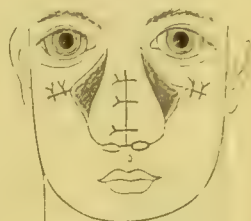
The following drawings show the shape of their flaps, and the manner of their adjustment :

FIG. 86.



(Syme.)

FIG. 87.



(Bell.)

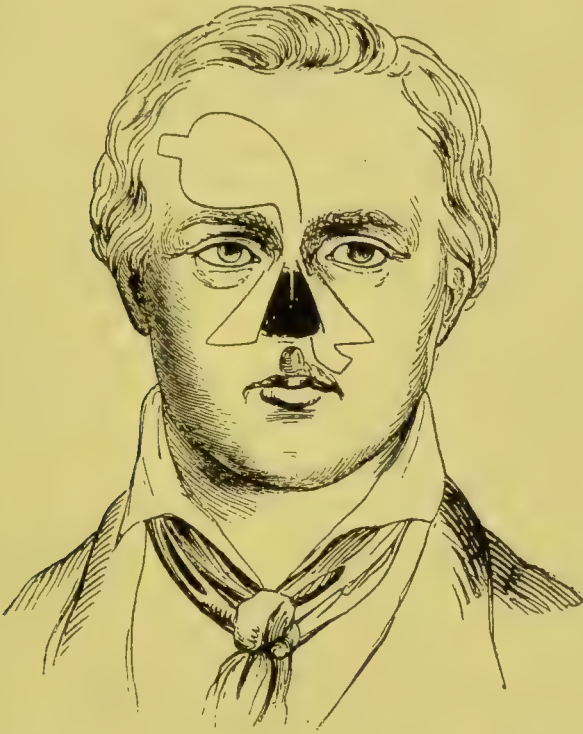
New flaps of the shape given in Fig. 86 are marked out on the cheeks with their conjoint pedicle above at the root of the nose, between the two inner canthi, extending sufficiently downwards and outwards upon the cheek to secure sufficient ampleness for the new nose, according to careful measurements already taken. The old nose being got ready by careful paring, the flaps thus marked out are dissected up and united in the middle line by three or four sutures, while the outer margins are fixed on each side to the raw surface, at a proper distance from the nasal orifice. Mr. Bell* advises that if any part of the old septum remain, it should be made very useful as a fixed point, a straight needle being thrust through one flap close to its outer lower edge, then through the septum, and out at a corresponding point of the other flap. The edges of the wounds left in the cheeks can generally be partially united by sutures of silver or fishing-gut, and the triangular portion, which must be left to heal by granulation, proves an advantage, as by its depression it enhances the apparent height and prominence of the new organ. The cavity of the new nose may, for the first few days, be kept gently distended by drainage-tubes drawn over pieces of catheter, through which the patient can breathe.

* *Manual of Surgical Operations* (4th edition), p. 176.

(3) **The Frontal or Indian Method.***—This method should be used when the soft parts of the cheeks are insufficient, when they are too cicatricial, or when an operation making use of them has failed. Its chief objections are the large frontal scar, and the liability of the single flap, though abundant and prominent at first, to shrink and fall in later on.

A piece of gutta-percha or leather is so cut that, when folded, it is of suitable shape and size for the new organ; it is then laid, opened out, upon the forehead, and the dimensions marked out

FIG. 88.



Flaps from forehead. Also flaps from cheeks. (Skey.)

with an aniline pencil or tincture of iodine. The flap thus drawn should be of the shape in Fig. 88, and, owing to the retraction of the skin, should measure $\frac{1}{4}$ inch more than the model in every direction. The average dimensions of the flap are thus given by Sir J. E. Erichsen:† when the whole nose requires restoration, it is usually necessary to make it about $2\frac{1}{2}$ to 3 inches long, and from 3 to $3\frac{1}{4}$ inches wide at its broadest part.

For the frontal flap, thus mapped out, a bed is now prepared by paring the old nose into a raw triangular surface; in doing this the knife must be used obliquely, cutting from without inwards towards the middle line, so as to leave a grooved surface sloping inwards. The warning of Erichsen (*loc. supra cit.*, p. 609)

* Introduced into European surgery by Mr. Carpué in 1816.

† *Surg.*, vol. ii. p. 608.

should here be remembered, not to remove the parts too widely, lest the cheeks later on retract and flatten out the nose. The bleeding being arrested by sponge-pressure, torsion, leaving on Spencer Wells' forceps (but not in this case by ligature), and covering over the raw surface with lint wrung out of warm boracic-acid lotion, the frontal flap previously marked out may now be raised. This is done by running a scalpel down to the periosteum, along the traced line, taking care that the pedicle should be sufficiently long to bear a little twisting, and sufficiently broad and thick to secure the presence of one if not both of the frontal arteries. To avoid any risk of stoppage of its blood-supply and sloughing, it is well to place the incision for the pedicle a little obliquely, with one side descending a little lower than the other—viz., on the side to which the flap is to be twisted. Where the level of the hairy scalp admits of it, this flap should lie a little obliquely, the tension being thus lessened. Where necessary, the flap may be taken transversely above one or other eyebrow, but the objection to this is, that the retraction of the scar upon the forehead draws the corresponding eyebrow upwards (Stimson). The frontal flap, however placed, is now raised from below upwards, so that the necessary hæmorrhage is rendered as little embarrassing as possible, and with as little handling, or pinching with forceps as possible. The knife should be kept away from the flap towards the periosteum, and used in the same plane throughout, without any scoring whatever. The hæmorrhage, free at first, is readily arrested by forcipressure (leaving on Spencer Wells' forceps for a while), or by sponge-pressure. The flap being sufficiently raised to hang freely and without tension, is then twisted slightly to one side (that on which the pedicle has been cut longest), and brought down and adjusted to the pared edges below by means of numerous fine sutures of salmon-gut, fine silk, or wire, and horse-hair, all being introduced with very small needles.

If the condition of the forehead has admitted of taking a columella from there, an appropriate groove must also have been cut in the upper part of the median line of the lip, and the two carefully adjusted. If no columella can be taken from the forehead the upper lip must furnish it, either now, if the patient's condition admits of it, or later on, when the pedicle of the frontal flap is divided. If no columella is made now, the flap, when attached, must be supported by gently introducing strips of some antiseptic gauze, well coated with eucalyptus and vaseline (3j—3i) ointment. If a columella is made, two bits of drainage-tube or Jacques' catheter are introduced. The parts, being painted with collodion and Jeyes' powder, are well covered in with aseptic gauze or salicylic wool, but in keeping these in position no pressure must be made with bandages on the new nose.

The forehead wound, on which sponge-pressure has been made, is now partially closed with one or two hare-lip pins and sutures, but in introducing these great care must be taken not to constrict

the pedicle of the frontal flap. Now and later on, healing may be here promoted by skin-grafting by Thiersch's method (*q.v.*).

The chief points in the after-treatment are not to change the dressings too frequently, and to use the utmost gentleness in doing so, to remove the sutures gradually, and to be on guard to prevent the onset of erysipelas or of secondary hæmorrhage. The former will be known by a sudden rise of temperature, vomiting, or nausea, and is best treated by warm boracic-acid lotion, applied by a mask of boracic-acid lint and by a sharp purge. Hæmorrhage may occur, according to Erichsen,* as late as the ninth day. It must be met by careful plugging with aseptic gauze, dusted with iodoform and tannic acid, or wrung out of turpentine.

The flap remains œdematous for some time, but, if not going to slough, it will be found warm and sensitive. If too much swelling persist, leeches or careful scarification should be used.

Separation of the root of the flap.

A month or six weeks later, when the blood-supply to the flap is established, the pedicle is divided with a narrow straight bistoury and cut somewhat wedge-shaped, with the apex upwards, an appropriate resting-place being fashioned for it in the skin beneath, which, up to this time, has not been touched. A few of the fine sutures already mentioned are then inserted.

If the patient has been feeble, or if the cheeks are very cicatricial, and thus the new blood-supply to the frontal flap be insufficient, some sloughing may take place, but this is rare.

Formation of a new columna.

If this was not made at the time of the first operation, it should be done at the same time that the pedicle is divided. It is rare that a forehead is sufficiently high to obtain an adequate columna, and the additional thickness and vascularity of the lip make it much more desirable to take one from here. Two assistants, with a finger and thumb at each angle of the mouth controlling the coronary arteries, and at the same time making the parts tense, the surgeon, with a straight narrow bistoury, transfixes the root of the lip just to one side of the middle line, and cuts straight down through the free border; a similar incision is made on the opposite side of the middle line, and a narrow strip, about $\frac{1}{4}$ inch in width, is thus detached save above. It is well, in a man, to shave off the skin and hair follicles, and the tip being pared, and the remains of the old columna appropriately freshened, the frænum is freely divided, and the new columna united to the remains of the old and to the alæ by one or two fine sutures. The cut surfaces of the lip are then brought most accurately into apposition with a silver wire suture opposite to the coronary arteries, and several points of fine silk and fishing-gut. A few more are next inserted to further adjust the columna.

* *Loc. supra cit.*, p. 611, is mentioned a case of Sir J. Lister's, in which hæmorrhage took place, on the ninth day, the patient losing over a pint of blood.

(4) **Italian or Tagliacotian Method.**—This is but very rarely made use of in this country owing* to the irksomeness which the needful position entails, and the need of a complicated special apparatus.

On the other hand, the absence of any additional scars on the forehead and cheeks, and the abundant flap which can always be obtained, are so important that it may be thought worth while to try this method in female patients who have sufficient time and means, and who will put up with the inconvenience of cramped restraint for two or three weeks.

Sir W. Mac Cormac brought a case before the Clinical Society † in which this method had answered well in a girl aged sixteen. The following account is taken from his paper. Means for keeping the patient's arm in the needful position for the requisite period were thus provided :

"A pair of ordinary stout well-fitting stays were first procured, to which were attached two perineal straps, to prevent displacement upwards. A helmet, partly made of leather, was connected with the stays by a leather band running up the centre of the neck and back. A leather armpiece, strengthened by a steel band, was moulded so as to extend from the wrist to the shoulder, where it was buckled to the stays. The wrist and hand were fastened to the helmet by a gauntlet, while the elbow could be fixed steadily in any required position by straps running from it to the stays, and to the sides of the headpiece, so that there was nowhere any undue strain, the pressure being so evenly distributed that each strap was almost slack. This apparatus was next applied for some days beforehand, so that any point of undue pressure might be remedied. The girl was able to sleep soundly in it, and it gave promise of proving perfectly efficient. Meanwhile I modelled on the deficient nose a gutta-percha substitute, and from this was able to project on a flat surface the extent of the deficiency. The first part of the operation was performed thus: A flap was marked out on the inner aspect of the left upper arm, more than double the actual size of the estimated deficiency. The left arm was the one chosen to supply the flap, and the right side of the nose the one first operated on, the septum being fashioned at the same time. The flap was left attached to the upper part of the arm by a broad long pedicle, and so arranged that there should be no traction whatever upon it, whilst the raw surface from which it was taken should be accessible for daily dressing. With the flap I dissected up the subcutaneous fat down to the muscular sheath. Immediate retraction both of the flap and of the denuded part of the arm took place to a large extent, so that the raw surface on the latter was almost co-extensive with the whole inner surface of the girl's arm, the flap appearing quite small in comparison. I now made a slightly curved incision, nearly parallel to the free border of the nose on the right side, and about three lines above it, corresponding, in fact, to where the alar furrow should normally exist. This incision was prolonged some little distance into the cheek in the line of the cheek furrow, whilst the remains of the septum were split open in the median line. This nasal flap could now be turned down so as to become horizontal, or rather a little depressed below the horizontal line, to allow for retrac-

* In cases where the destruction is very great, where other methods have failed, where the skin available on the face is much scarred or of doubtful soundness, the Tagliacotian method is especially indicated.

† *Clin. Soc. Trans.*, vol. x. p. 181. Three figures are given, of the patient before and after the operation, and of the apparatus used.

tion of the ingrafted piece. A triangular gap, the apex pointing towards the cheek, was thus left exposed on the right lateral aspect of the nose, and into this the triangular-shaped piece from the arm was inserted, and accurately attached by suture, the portion to form the septum being sutured in the groove already formed by splitting the septum. In this way there was no paring of edges, nor was a single particle of nose tissue sacrificed, whilst by having so large a line of attachment, being almost surrounded by living tissue, the new flap was much more likely to adhere satisfactorily in the first instance, and from its freer blood-supply less prone perhaps to subsequent contraction." Union took place in great part by first intention, some suppuration setting in on the eighth day, owing to the indifferent plastic power of the subcutaneous fat. Healing was not complete for nearly three weeks. At this date the operation was completed by detaching the flap from the arm, cutting this so as to give it a triangular shape, and preparing the left side of the nose to receive it in a manner precisely similar to the right. The perfect vitality of the now completely severed tissue of the arm was made apparent by copious hæmorrhage, and healing was complete in a fortnight. After the first forty-eight hours scarcely any inconvenience was felt from the apparatus, save for a slight excoriation on one shoulder. The result was good, but it was expected that further contraction would much improve the aspect of the nose, the new organ being fully large.

Causes of Failure after Complete Rhinoplasty.

1. Gangrene and sloughing.
2. Secondary hæmorrhage.
3. Erysipelas.
4. Destruction of the new nose by recurrence of the old disease.
5. Too large a nose.
6. Too small a nose.

B. Operations for Partial Restoration of the Nose.

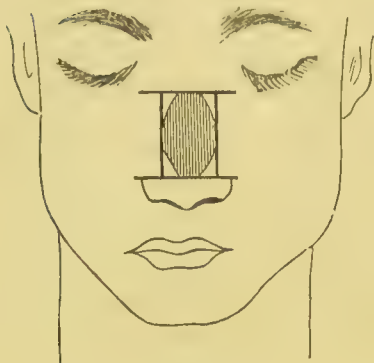
—These are very numerous, and have usually been designed for special cases. A few only will be alluded to here.

(i.) One of the most successful of these is the **method of Surgeon-major Keegan** whose name is so well known in connection with lithotrity. Practising for many years at Indore, he had ample opportunities of performing rhinoplasty, it being well known that slicing off the soft parts of the nose is a very common mutilation in India, especially in the hands of jealous husbands. Such cases are most favourable for operative measures, the patients being young and healthy, and the bridge of the nose left. Two small flaps of skin, with their attachment below, are turned down off the nasal bones so that their cutaneous surface looks backwards, and their raw surface forwards, their lower margins forming a natural cuticular lining to the new nostrils. On to the raw surface over the nasal bones and the raw surface of the deflected flaps, a forehead flap of somewhat modified shape is brought. The results are excellent, the nose being prominent and shapely, and free from risk of subsequent contraction. This method is clearly the best for cases where the cartilages, alæ and columna are gone (*Lancet*, vol. i. 1891, p. 419).

(ii.) **Two Lateral Flaps.**—This method is indicated when the lower third of the nose is left untouched and the central portion especially destroyed. (a) Small square flaps are raised and united in the middle line (Fig. 89). (β) Another method is shown in Fig. 88. It was made use of by Mr. Skey (*Operative*

Surgery, p. 523), who thus describes it: "In cases in which the ossa nasi are destroyed, the operation consists in bringing to the mesial line two lateral flaps made from the side of the nose upon the cheek. The calculations in this operation are nearly as important as in the frontal method. An incision is commenced at the root of the nose, as nearly as possible on the dorsum, and carried down as close to the line of the former organ as the condition of the skin will permit, and a second, commencing $\frac{1}{2}$ inch on the outer side, should extend downwards, curving at the same time a little outwards, to avoid the orbicularis. The second incision should diverge from the first towards the cheek-bone, and at its extremity, which should correspond with the line formed by the base of

FIG. 89.

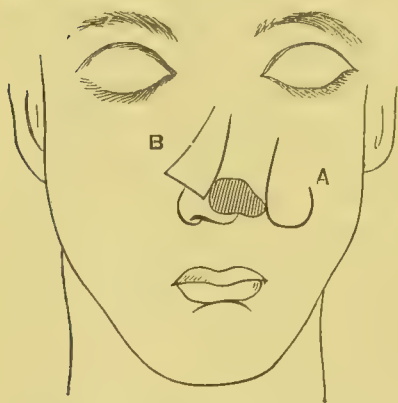


Rhinoplasty. Double square lateral flaps. (Stimson.)

the nostril, should be distant more than a full inch from it." Mr. Skey advises that the columella be made at the same time, attached to one of the flaps as shown in Fig. 88. If this fail, the lip will still serve the surgeon's purpose.

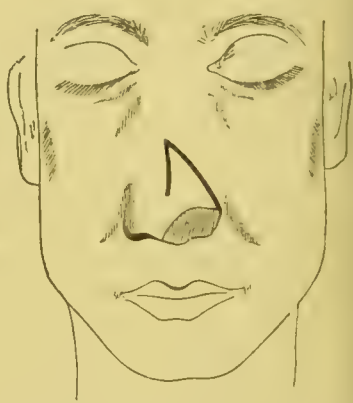
(iii.) **Single Lateral Flap.** — This may be taken in many different ways. (a) From the cheek, at the side of and below

FIG. 90.



Rhinoplasty. Single lateral flap. (Stimson.)

FIG. 91.



Rhinoplasty. Denonvilliers' method. (Stimson.)

the nose (Fig. 90 A). (β) From the opposite side (Langenbeck). The apex of the flap is left attached to the inner angle of the eye, on the same side as the deficiency, while the base comes from the ala of the sound side (Fig. 90 B). (γ) M. Denonvilliers' method. A border that has already cicatrised is made use of so as to prevent subsequent narrowing. A triangular flap is marked out by incisions shown in Fig. 91, the pedicle being internal. The

flap, having been carefully raised with a strip of cartilage in its lower margin, is displaced downwards into position.

In all the above methods, if cartilage is not included in the free border which is to form the new ala, the flaps should be cut long enough to allow of turning this border upon itself and thus giving a thicker and more natural appearance to it.

(8) M. Weber's Method. The flap is taken from the upper lip: on account of the hair follicles this plan is best suited to women. An oval flap is taken, usually from the centre of the lip, with its pedicle left attached close to the columna and its free margin reaching to the prolabium. The flap, which consists only of part of the thickness of the lip, is turned up, and stitched to the remains of the ala, which have been refreshed. In three or four weeks this pedicle is divided, and may be so united to the inner surface of the flap as to give it a thicker and rounded margin.*

ROUGE'S OPERATION.†

Indications.—Whenever the surgeon desires to gain free access to the nasal cavities, as in cases of—

1. Intractable ozæna.‡ Thus, when previous persevering treatment, including Thudichum's douche, fails to cure cases of strumous ozæna, with obstinate inspissated crusting of discharge under the turbinated bones; when dead bone is detected by a probe, or is believed to be present in these cases, or, more commonly, in those of syphilitic ozæna. 2. In inveterately recurring nasal polypi, persisting after the steps advised at p. 296. 3. In some cases of naso-pharyngeal polypi—viz., where the growth is small, and where a scar is especially deprecated.

Operation.—An anæsthetic having been administered, the surgeon must decide as to what steps he will take to prevent the blood from getting down into the pharynx. This may be done either by plugging the posterior nares, or by performing laryngotomy and plugging the fauces with a sponge (pp. 366, 384). If the hæmorrhage is likely to be troublesome, and the operation prolonged, I much prefer the latter precaution, for I have found that when the nostrils are plugged it is quite possible to sever the silk on one side, owing to its being hidden by clots, and its whereabouts thus not seen.§

* For the account of these lateral flap operations and for Figs. 89, 90, 91, I am indebted to Dr. Stimson's *Operative Surgery*.

† *Nouvelle Méthode pour le Traitement chirurgical de l'Ozène*, par le Dr. Rouge. Lausanne: 1873.

‡ Mr. Hayward (*Syst. of Surg.*, vol. ii. p. 644) believes that in a large number of cases of ozæna the discharge is due to a carious surface being present on the base of the skull. If this view is correct, it obviously points to not putting off this operation too late.

§ Plugging the fauces after a laryngotomy has the further advantage of leaving the posterior nares free for examination by a finger passed from the mouth,

The upper lip having been well raised and everted by an assistant taking hold of it at the angles of the mouth, the surgeon frees it from the upper jaw by an incision through the mucous membrane reaching from the bicuspid teeth on one side to their fellows. In doing this the knife should be kept close to the bones and parallel with them. The cartilaginous septum is next detached from the anterior nasal spine, and the lower lateral cartilages from the upper jaw, the adjacent parts of the cheek being also freed at the same time sufficiently to admit of the nose and lips being lifted up sufficiently to explore the nasal cavities.

After any dead bone has been removed, the sharp spoon applied, and the nasal cavities thoroughly cleansed in cases of ozæna, or any polypi dealt with, the parts are replaced (without sutures), and iced boracic-acid lint applied until the pain and swelling have subsided, and the risk of erysipelas has gone by.

Other operations on the nose—*e.g.*, those of Lawrence and Ollier—are given later on under the heading of Naso-pharyngeal Polypi, pp. 314, 315.

REMOVAL OF NASAL POLYPI.

After repeated use of Mr. Mitchell Banks' method, I believe that in its thoroughness, and the simplicity of the instruments required, it is far superior to snare, injection with iron perchloride, &c., and the galvanic loop. Of the above, the first is, aided by a 20 per cent. solution of cocaine, an excellent means of getting rid of the larger polypi which come down first, but it is, I think, tedious and inefficient in the case of the crops of the smaller ones, often sessile, which make their appearance later on. I have never found that the abundant hæmorrhage causes any serious trouble, as long as the assistant who administers the anæsthetic knows his business, and as long as the patient's head is kept on one side, over the edge of a table or sofa.

Mr. Banks' method is given in his own words : *

"As to the most permanently curative operation for nasal mucous polypi, I believe there is nothing equal to the use of the forceps properly managed. Where there are large isolated polypi with well-marked stalks, the wire snare or Dr. Thudichum's process may do well enough, and probably removes them with much less pain than the forceps. But these are not the most common cases. On the contrary, they are usually crops of small growths fringing the superior and middle turbinated bones, which no snare can get hold of, and which in due time make their appearance as large ones. Mr. Syme, after great experience, used to say that the only

a point of importance in examining these parts, or in manipulations in the case of a polypus.

* *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 180.

way was to get one blade of the forceps beneath the turbinated bone and the other on the opposite side of it, and to carry away as much bone as possible. This I always endeavour to do, and find that, along with the big ones, I have brought away whole crops of minute polypi just commencing their existence, which can only be removed by carrying away the bone from which they grow. As to necrosis and all sorts of contingencies which it is said *may* occur as a result of such rough surgery, the simple answer is, They don't occur. On the other hand, the patient has a chance of getting rid of the source of his trouble, and does not need to come every two or three years to have a fresh assault made upon a fresh lot. Failure often results from using forceps which are too big in the blades, and which are only toothed in the points instead of all the way down. In not a few cases where the patient has had several operations performed previously by other surgeons, I have simply smashed up the whole turbinated bone as widely as I could, and so have settled the matter permanently. Now the pain and dreadful sensations produced by this proceeding are more than mortals can bear, and so the patients have had chloroform or ether, and it would be an excellent thing if this were resorted to more frequently. Even a moderate assault with the forceps is a most horrid process, and patients who have gone through it once or twice, will endure any amount of chronic misery rather than face it again. But only a very few surgeons seem inclined to give these unfortunates an anæsthetic, urging as their reasons the danger of blood going down the throat and choking the patient, and the fact that, owing to the patient being insensible, he cannot blow down the nostrils so as to let it be known whether they are clear or not. My plan is to have the patient thoroughly anæsthetised on a sofa. When fully insensible his head should be brought over the edge so that the nostrils are dependent, and then the surgeon, kneeling on the floor, passes up the forceps, and pulls out everything he can till there is nothing more to pull. Meantime, all the blood runs out of the nostrils, and none need go down the throat at all, while the whole time necessary for a thorough cleaning is about a minute for each nostril. I feel convinced that, for certain cases, the only satisfactory cure is to pull away as much as can be got of the superior and middle turbinated bones."

From my own experience of this method I agree with every word of the above, save that I would substitute middle and inferior for "superior and middle" turbinated bones. It is from the lower two bones that these polypi spring. In the second place, the points of the forceps should always be kept backwards parallel to the two lower turbinated bones, not upwards to the base of the skull, or fatal mischief may easily be inflicted upon the delicate bones met with here.

ADENOID GROWTHS OF NASO-PHARYNX.

These growths should be operated on more frequently than is the case, owing to their pernicious effect upon the voice, hearing, and features. They are often a cause of recurrent coryza, and may produce disappointment after the tonsils have been removed. In addition to the symptoms produced by habitual breathing through the mouth only, the finger passed behind the soft palate detects a number of velvety, sessile, friable masses. These bleed readily, and block up the posterior nares. As the landmarks are lost, I have found Lennox Browne's advice, to commence by feeling for the septum, and then to explore above and below and on either side of this as a starting-point, helpful. In children the growths are best removed with the finger-nail passed behind the soft palate. This will also guide a Volkmann's spoon passed through the anterior nares. Of other means, I prefer Meyer's ring scraper to Löwenberg's forceps. Especial care should be taken in working near the Eustachian tubes, as roughness here may lead to otitis media. The hæmorrhage is free, but ceases spontaneously. Ether should always be given, as this admits of the patient being safely propped up, with the head a little forwards, to facilitate the escape of blood; the child should be in a good light, and a small gag inserted. It may be needful to repeat the operation in a bad case, or where, from a relatively large tongue, great hypertrophy of the tonsils, or much accumulation of pharyngeal mucus, the time as well as the space for operation has been limited; otherwise any remaining growth soon atrophies.

Mr. Sheild (*Dis. of the Ear*, p. 213) gives the following cautions: Considering the readiness of the scarlet fever virus to attack the naso-pharynx, these cases should not be operated on where cases of scarlet fever are prevalent. It is well to inquire into the possibility of the patient being of the hæmorrhagic diathesis. The sanitary surroundings of a child operated on in a private house should be perfect. Where any deafness is not relieved by the removal of the adenoids, methodical after-treatment, such as the inflation of the ears by Politzer's process, should be instituted.

CHAPTER VII.

OPERATIONS ON THE JAWS.

OPERATION ON UPPER JAW.

THESE will include—

- i. Removal, partial or complete, for growths (Fig. 92).
- ii. Operations for naso-pharyngeal polypus (Figs. 124, 125).
- iii. Opening the antrum.

REMOVAL OF UPPER JAW, PARTIAL OR COMPLETE.

Indications.—These include the different growths to which the upper jaw is liable, and opportunity will be taken here to give briefly the chief practical points in connection with these.

1. **Epulis.**—One of the new growths most frequently met with here. Etymologically gum tumours, these growths vary a good deal. At first, and most frequently, they are simply fibrous, tough and firm, springing from the periosteum, the periodontal membrane, and the endosteal lining of an alveolus. Myeloid cells and small spicula of bone are not uncommon. The longer they are left, the more they are irritated, especially with imperfect attempts at removal, the more cellular and sarcomatous do they become.

Very rarely on drawing the tooth, to the alveolus of which the growth is connected, the epulis comes away completely. Much more frequently it is firmly connected to the periosteum and subjacent cancellous tissue, or the endosteal lining of one or more alveoli. Removal should be early and complete. Shaving off the growth and the gum beneath, and then applying caustics to any suspicious granulations, is most uncertain and unsatisfactory, especially if the presence of teeth is allowed to interfere with the complete removal of the growth, or if this is connected with stumps, and thus dips deeply into an alveolus. By far the best treatment is to draw a tooth in front and behind the growth, and then with a narrow saw to notch the bone at these points deeply through the alveoli: with cutting-forceps, or better, a chisel and mallet, a V-shaped or rectangular piece of the bone is then removed. The drawing of teeth not only enables the surgeon thoroughly to eradicate the growth, but their removal leads, as

pointed out by Mr. Salter,* to wasting of the alveolus and thus to non-recurrence of the growth. The teeth, if sound, should be preserved, and, later on, when all is firmly healed, fitted to a plate by a dentist. The deformity is thus rendered imperceptible.

In 1884, a captain in the Royal Navy, whose ship was on the North American station, came under my care with an epulis of the lower incisors and contiguous alveolar margin. The teeth were all preserved, and when the parts were soundly healed, Mr. Moon refitted them so skilfully that no trace whatever of an operation could be noticed, and the use of a speaking-trumpet, which was most essential in this case, was not interfered with.

If a patient refuses the only operation which is safe, the surgeon must rest satisfied with shaving off the growth, gouging the subjacent bone, and, if needful, applying caustics to any suspicious patches later on. This course is not only much more tedious and painful, but is uncertain to boot.

2. Fibroma.—These originate either in the periosteum or in the endosteum of the antrum. At first firm, dense, and slow-growing, they may, from the frequent irritation inseparable from their site, become vascular, sloughy, and, taking on more rapid growth, tend to invade the numerous fossæ, fissures, and foramina in the neighbourhood of the bone. They should be attacked early, and while the surgeon may need at this stage to remove only the periosteum and bone from which the tumour springs, especially if it be alveolar in origin, or after opening the antrum to shell out the fibroma completely, he must also be prepared for more radical measures, especially if the growth is of long standing, of late more rapid, if the patient is at all advanced in years, and especially if the growth is recurrent.

3. Sarcoma.—These include the spindle, round, and myeloid varieties, the fibro-, chondro-, osteo-sarcomata, and the rarer form of alveolar sarcoma. While the more slowly growing ones simulate more innocent growths, such as epulis, the more rapid ones will tax the surgeon's judgment as to whether any operation is justifiable, and all his skill, if removal is attempted. On these subjects the reader is referred to p. 304.

4. Carcinomata.—At the present time the softer growths which attack the jaw, and were formerly called medullary cancers, are looked upon as rapidly growing sarcomata. The only true carcinomata met with here are epitheliomata. These are usually of the squamous kind, and commence in the alveolar border in ulceration, beginning in syphilis or the irritation of an ill-fitting tooth-plate. They tend to creep far back and to invade the palate and tonsil; on this account they should be operated on early. Whenever a sore in this position is suspicious in its characters, and obstinate to treatment, whatever be the age of the patient, the parts affected should be widely and freely extirpated. If the

* *System of Surgery*, vol. ii. p. 456. Mr. Salter also points out that where an epulis forms on an apparently edentulous part of the jaw, the existence of stumps should always be looked for.

growth has eaten into the antrum or has travelled back so as to invade the pterygoid region, removal of the whole bone is most likely to benefit the patient. More rarely a squamous epithelioma attacks the jaw from the lip or face. This happens much more often in the case of the lower jaw. Another epithelioma met with here is the tubular* variety (cylindrical or adenoid carcinoma), which begins in the mucous membrane of the antrum or nose. It is marked by rapidity of growth and invasion of the surrounding parts, and is thus of grave prognosis.

5. *Dentigerous Cysts*.—These are formed by a collection of serous fluid taking place during the development of a tooth, nearly always a permanent one, which has not come through.†

There are two varieties of these cysts; one, the commonest, is cystic only, consisting of an outer bony shell of varying thickness and an inner membranous one. The tooth may be well formed or a small, shapeless, calcified mass: its crown usually projects into the sac, vertically or horizontally.

The following points are of practical importance. These cystic swellings may be taken for solid growths, but this mistake may be avoided by remembering that when such a swelling exists there is usually a history of its having commenced in early life, and that though all the teeth may appear to be present, one will very likely be found to be a temporary one. Furthermore, there is the help derived from puncture with a fine trocar.‡

The treatment consists in exposing the surface of the cyst by turning the lip up, or by making incisions through this as small as possible, then in cutting away freely (with bone-forceps aided by a $\frac{3}{4}$ -inch trephine if needful) the walls of the cyst,§ so as to examine its contents, and then digging out the tooth, often the most difficult part of the operation. The cavity is then carefully stuffed with strips of aseptic gauze to encourage its granulating from the bottom. If any swelling persist, keeping up deformity, pressure must be trusted to, a Hainsby's truss being here found useful.

In the other variety of dentigerous cysts, solid growth of a sarcomatous nature is present in addition to the cystic. The

* Mr. Heath (*Dict. of Surg.*, vol. i. p. 857) quotes Réclus as calling this form *epithelioma térébrant*, from its boring or burrowing tendency.

† Mr. Salter (*Syst. of Surg.*, vol. ii. p. 469) gives the following three circumstances as capable of producing impaction of a tooth:—(1) The tooth may be originally developed too deep in the body of the jaw—thus, though it grow in the right direction, it will never reach the alveolar margin; (2) while it may be sufficiently superficial, it takes an oblique direction of growth, so that it lies covered more or less in the axis of the bone; (3) the position of the tooth and its line of growth may be originally normal, but from arrest of the development of the fang it may fail to reach the alveolar edge.

‡ Mr. Fearn, of Derby, was candid enough to publish a case of this mistake in diagnosis in the case of the lower jaw, *Brit. Med. Journ.*, August 27, 1864. The specimen is figured in Mr. Heath's *Injuries and Diseases of the Jaws*, p. 162, and shows well how such a mistake might have arisen.

§ A good illustration will be found in Mr. Bryant's *Surgery*, vol. i. Fig. 194.

surgeon here must use his discretion as to opening the cyst, freely scraping out the growth and then applying the cauterly or zinc-chloride paste, or removing the bone itself. If the case is of any duration, if the growth is soft and making rapid progress, the latter course will be the wiser one.

6. Enchondromata.—These are rare. They seem to commence in adolescence, usually starting from the surface of the bone—*e.g.*, the nasal, or from the antrum. They should be removed early and completely, as they grow steadily, involving the nose, orbit, frontal sinuses, and thinning the cranial bones.*

7. Osteomata.—These are rare also. Two forms occur: (1) of the nature of an ordinary exostosis. These are usually cancellous, but ivory ones arise from the superior maxilla as well as from the orbit and frontal sinuses. Occasionally they are symmetrical.† Their growth is usually slow. If they occur in young subjects they should be attacked while small. The ivory exostoses are occasionally found loose on laying open the antrum, as is the case with those in the frontal sinuses. (2) Diffuse osteomata. These are intermediate in hardness between cancellous and ivory exostoses. They have often broad, ill-defined bases, and are often multiple and symmetrical. As they tend to produce hideous deformity, and, though slowly, most distressingly, to destroy life, they should be attacked while small. Mr. Pollock‡ quotes Mr. Stanley§ as an authority for the fact that in cases where the whole mass is beyond removal, a portion may be cut away with present, if not permanent, benefit. This can only apply to osteomata of purely hypertrophic nature. Where the bony growth is tipped with cartilage every atom must be removed for the operation to be of any benefit. Well-made osteotomes and drills worked by a dentist's instrument may be of much service here, the great object being to drill a number of holes in different directions through the growth, and then to cut through the intervening bone with well-made osteotomes and a mallet. One of the chief risks is that of intra-cranial inflammation, especially if the growth has involved the interior of the skull.

8. Odontomes.—These are very rare, and usually occur in the lower jaw. They are liable to be mistaken for osteomata or necrosis with anomalous symptoms, as in one occurring in the upper jaw (Jordan Lloyd, *Lancet*, 1888, vol. i. p. 64).

Questions arising before Attempting Removal of the Upper Jaw.

(i.) Is the growth cystic or solid? (ii.) What is the relation of the growth to the jaw? Did it begin on one of the surfaces

* Good instances of what these enchondromata may come to are given by Mr. Morgan's case, *Guy's Hosp. Reps.*, 1842; Mr. Heath's *Diseases and Injuries of the Jaws*, p. 237, with an excellent illustration, Fig. 107.

† In Mr. Hutchinson's *Clinical Surgery*, vol. i. p. 11, Figs. 3, 4, will be found admirable illustrations of symmetrical exostoses from the upper jaw.

‡ *Syst. of Surg.*, vol. ii. p. 535.

§ *Diseases of Bones*, p. 5.

of the jaw, within the antrum, or behind the jaw? (iii.) Is the growth one, whether malignant or not, that it is wise to attempt to remove?

(i.) **Is the Growth Cystic or Solid?**—A case already quoted, at p. 301, shows that mistakes may arise here. Mr. Heath gives a case under his own care in which caseous pus, after suppuration in the antrum, was taken for a solid growth and the jaw removed. As the diagnosis is evidently most difficult in some cases, the surgeon should, in all cases of doubt, explore first with a trocar and cannula or a drill or bradawl.

(ii.) **What is the Relation of the Growth to the Jaw?**—Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw?

In some cases it is quite impossible to be sure on this point up to the time when the flaps are reflected or till the jaw itself is removed; even the use of a finger aided by an anæsthetic is insufficient.

The following points may be useful in aiding a decision as to the relation of the growth to the jaw:

If the growth began on the surface of the jaw—*e.g.*, the nasal or malar process—there will probably be a history of a lump noticed here first, very likely after a blow, and any evidence of the antrum, nose, palate, and orbit being involved will be deferred till late. On lifting up the cheek, masses of growth will very probably be found creeping down between the cheek and gums, but not altering the line or affecting the structure of the alveolus, unless it commenced in it or just above it.

If the growth began in the antrum, the cheek is more slowly swollen, and the swelling is deeper and less defined. The different walls and boundaries of the cavity—*viz.*, the orbital, nasal, facial, and zygomatic—are expanded steadily and with a varying rapidity, while the palate is depressed, and the alveolar border displaced, and the teeth rendered irregular.

If the growth began behind the antrum—*e.g.*, in the basilar process of the sphenoid or the pterygo-maxillary fossa—in many cases a history will be given of polypi removed from the nose or pharynx some time before, perhaps recurring soon; the upper jaw is pushed forwards, and in some cases there is but little alteration in its outward shape, but this is by no means constant. Not unfrequently the upper jaw will be so altered by pressure, its processes—*e.g.*, the malar—so thinned, flattened, and expanded, that it may well be thought that the disease began in the bone itself. And this mistake is the more excusable when it is remembered how easily a growth situated behind the antrum may make its way into this cavity, either by absorbing its walls, or by entering it through the opening into the nose.

If the growth has begun behind the antrum, starting from the base of the skull, symptoms pointing to blocking of the nose—*viz.*, pain here, in the orbit and brow; epiphora from blocking of the

nasal duct, interference with nasal breathing, epistaxis, &c.—will most probably be present, yet it must be remembered that many of these symptoms will be brought about by a growth within the antrum increasing rapidly.

It is only, I think, when the surgeon finds no evidence of the growth beneath the skin, or of its originating on the surface of the bone, no depression of the palate, and no irregularity of the alveolar margin or displacement of the teeth, that he can say that the growth is probably behind the antrum.

(iii.) Is the Growth one, whether Malignant or not, that it is wise to Attempt to Remove?—While every case must be decided upon separately, and while it would be most misleading to lay down hard-and-fast rules, the following are not unworthy of attention:

Favourable Cases.—Growths with a duration extending over many months, hard, well-defined, limited to the jaw, with the skin over the growth perhaps thinned from pressure, and altered in colour, but still movable over the parts beneath.

Unfavourable Cases.—History of a few months' duration; growth soft, vascular, ill-defined; integuments involved and fixed; nasopharynx invaded; extension into orbit or temple—*e.g.*, a soft, semi-elastic swelling noticed behind the malar bone in the temporal region; extension to the sub-maxillary and cervical glands; origin of the growth behind the jaw, rather than on it.

Occasionally, a growth, unfavourable at first sight from its large size, will be found to have protruded on to the face without involving the parts around, and especially those behind.

The history must be carefully examined into. If it be doubtful where the growth began, whether it has invaded or only crept towards the nostril, the surgeon will inquire as to the existence of deep-seated pain, stuffiness in the back of the nose, loss of smell, interference with nasal respiration, epistaxis, &c. Again, the existence of any swelling near the inner canthus will point to extension towards the ethmoid and base of the skull.

Complete Removal of Upper Jaw (Fig. 92).—The patient having been brought carefully* under an anæsthetic, and duly propped up, the face shaved, and the head raised and turned over towards the opposite side, the surgeon takes this opportunity of examining more completely the attachments and limits of the growth, and decides whether, owing to its vascularity, it will be wiser to perform a preliminary laryngotomy and plug the back of the pharynx (p. 366), or to place a temporary ligature on the carotid.

* As in excision of the tongue, the assistant to whom the anæsthetic is entrusted is second only in importance to the surgeon. He should watch most carefully for the first signs of flagging of the pulse, and meet this by injections of ether or brandy. Any evidence of blood going down the throat, dyspnoea (as shown by venous stasis of the cheeks), lividity of the lips, or respiration short and fixed, must also be looked out for.

The incision, which goes by the name of Sir W. Fergusson,* is then made through the centre of the lower lip (an assistant controlling the opposite coronary while the one in the flap is commanded by the surgeon himself), round the ala, and up along the side of the nose to the inner canthus, and then outwards just below the margin of the orbit, as far as the malar prominence. The flap thus marked out is then reflected, and though no large vessels are cut, the hæmorrhage is often free, especially in cases of rapidly growing tumours which have thinned the bone. Spencer Wells' forceps are applied to the larger of these, while the flap is being reflected these are secured, and an assistant makes sponge-pressure if needful upon the flap to arrest oozing, while the surgeon divides the bones in the following order, the ala of the nose being first detached from the bony margin, and the periosteum of the floor of the orbit freed :

(1) The junction of the jaw with the malar bone is divided. The line for the saw is marked out with the knife upon the bone just in front of the origin of the masseter. With a narrow strong-backed saw (Fergusson's or Adams' osteotomy saw) this line is converted into a deep groove and the rest of the bone quickly severed with forceps, the left forefinger placed upon the margin of the orbit steadying these instruments and preventing any damage to the eye. This bone section is practically in a line with the sphenomaxillary fissure (at the lower and outer part of the orbit), and should fall into it.

(2) The nasal process of the superior maxilla is next severed by cutting a saw-groove across it, and then placing one blade of the forceps inside the nostril and the other against the inner angle of the orbit, the soft parts being first a little freed and carefully kept out of the way with the left thumb-nail.

(3) The central or a lateral incisor being next drawn, the mouth is widely opened with a gag, and an incision is made with a stout scalpel along the middle line of the hard palate up to the teeth, and then another transversely outwards at the junction of the hard and soft palate, towards the molar teeth on the side affected. The soft palate is then detached with a scalpel or blunt-pointed

FIG. 92.



Removal of upper jaw. Reflection of flap, and section of bones.

* First recommended by Dieffenbach. Its advantages are very great—viz., (1) only the terminal branches of the facial nerve are divided ; (2) only branches of the facial vessels, not their trunks, are cut ; (3) the scar left is much less conspicuous, as the incisions are placed in the natural feature-folds.

scissors, and thus preserved when the bone and growth are wrenched away. The hard palate is then deeply notched with the saw introduced through the nose opposite to the tooth which has been drawn, and severed with bone-forceps, one blade of which is introduced within the nose, the other into the mouth. If a chisel or osteotome is now inserted into the different lines of bone section, the bone is loosened with a series of quick and careful levering movements, while finally lion-forceps being made to bite firmly into the hard palate and the malar aspect of the bone just below the infra-orbital foramen, the bone is detached by a few wrenching, rocking movements upwards and downwards, and laterally, while the left fore-finger detaches any soft parts which retain the bone, the superior maxillary nerve being cut cleanly with scissors.

When the bone has been much invaded by disease, or in the case of an aged dead body, it is very likely to come away in fragments, being unavoidably crushed down by the forceps.

On the removal of the bone, the pterygoid fossæ, the cavity of the nose, and the palate are examined, and the sharp spoon applied to remove any remaining portions of disease, or Paquelin's cautery made use of to destroy any of these which cannot be otherwise removed.

The bleeding is seldom free at this stage, save in rapidly growing cases, as the branches of the internal maxillary are small before they reach the tumour, and, as they are torn through, it is usually arrested by firm sponge-pressure.

If there is any doubt about any of the growth being left behind, some paste of zinc chloride, made up with equal parts of flour, had best be inserted on lint to which silk is attached, the threads being brought out of the mouth through the palate, and so readily removed in a few days. But if the bone has come away with all the growth, if the surface of this is smooth and encapsuled, not ragged or lacerated, the surgeon will do best to insert nothing into the cavity. If oozing is going on, or if there is reason to fear intermediary hæmorrhage, strips of iodoform or sal alembroth gauze should be carefully packed in, and removed later on by the mouth. But it is difficult to keep even these sweet, and the surgeon will do best to dispense with any plugging if possible, and to content himself with brushing over the wound with a solution of zinc chloride (gr. xx-3j), or with a solution of iodoform in ether. The edges of the wound are then brought together with a few points of salmon-gut or silver suture, one or two of these being always inserted in the lip, and others of gut or horse-hair, or carbolised silk. Especial care should be paid to adjusting the red line. Collodion and Jeyes' powder or iodoform is then painted on, and the usual gauze dressings or a pad of boracic-acid lint wrung out of the saturated lotion, and kept constantly moist, applied.

During the after-treatment the patient should be kept well propped up to facilitate the escape of discharges, which must be

prevented from collecting by frequent syringing, or, what is better, by the patient himself often rinsing and gargling his mouth and wound with some safe antiseptic solution, *e.g.*, potassium-permanganate lotion, one of spirit of wine, $\frac{3}{4}$ ss to a tumbler of water, or one of creolin or izal. The wound at first should be occasionally brushed over with iodoform in ether (1 in 8). If needful, the patient should be fed with a soft tube for the first few days.

In those cases, rare nowadays, where the growth is of great size; owing to the operation being deferred, the mouth may remain open for some days after, but the power over the muscles which raise the lower jaw is gradually regained. The lost sensation is usually restored, and the resulting deformity is often very slight.* Later on, when the parts are soundly healed, the skill of a dentist is called in to fit on a tooth-plate,† and obturator if needful.

Partial Extirpation of the Upper Jaw.—Operations for removal of an epulis with the alveolar border have been described at p. 299, and one for opening up and exploring the antrum is given at p. 319.

If the surgeon find that the lower part only of the upper jaw need be removed, abundant room will be given by dividing the upper lip in the middle line, prolonging this round the columella into the nostril on the diseased side. By detaching the nose and dissecting up the flap of cheek the facial surface of the jaw can be well exposed.

Again, if, after exposing the whole jaw by Sir W. Fergusson's incision, the surgeon find that the orbital plate can be spared, a horizontal saw-cut is made just below the infra-orbital foramen and the bone cut through with a chisel and a few taps of a mallet.‡

When the orbital and nasal parts of the upper jaw are involved and the lower alveolar portions are sound, these latter may be thus preserved. A cheek-flap being reflected by an incision through the lip and upwards to the inner canthus along the nose, the nasal and malar processes are divided while the eye is duly protected. A horizontal saw-cut is then made above the alveolar process, outwards from the nose, and another carried upwards from the outer end of this, to join the incision through the malar process, being made either with the saw or chisel. The piece of

* No skin is, of course, removed, even if it appears to be very redundant; it rarely sloughs, save when the stretching has been extreme, or when it has been needful to apply the cautery to the flap. When the growth has invaded the skin over it, a hideous fistula is left, which must be closed later on, if the patient survives, which he seldom does in these cases.

† Mr. Butcher (*loc. supra cit.*, p. 270) in one case preserved the last molar tooth and part of the tuberosity as a fixed point for a tooth-plate, intending to have removed this if the disease recurred in it subsequently.

‡ The orbital plate should always be left if possible. As Mr. Butlin (*loc. supra cit.*, p. 134) points out, when the floor of the orbit has been removed there often results not only serious disfigurement, but much œdema of the lower lid, and an unhealthy condition of the eye itself, which may be destroyed.

bone thus mapped out is loosened with a chisel or elevator, and either prised out with the latter instrument, or wrenched downwards and outwards with the lion-forceps.

Several other operations involving partial removal of the upper jaw are given under the treatment of naso-pharyngeal polypus (p. 311).

Difficulties and Dangers during the Operation.—These have been already alluded to: the chief are—

1. Shock.
2. Hæmorrhage.
3. Breaking down of the bone in the lion-forceps.
4. Outlying pieces of growth either in the pterygoid or other fossæ, or in the temporal region, or far back in the roof of the nose.

Possible Causes of Failure.

1. Prolonged shock. Inability to rally. Besides the usual application of warmth and injections of ether and brandy, feeding by nutrient enemata or by a tube passed by the mouth or by the opposite nostril should be early resorted to, especially in the case of elderly patients, or in those much let down.

2. Secondary hæmorrhage. If this is severe, resisting the use of ice, &c., the wound must be opened up, and if no definite bleeding point be found, firm plugging must be resorted to, either with iodoform gauze wrung out of carbolic-acid lotion (1 in 20) and dusted with iodoform, or the same, with the ends in the wound wrung out of turpentine. These steps failing to arrest the hæmorrhage, ligature of the common or the external carotid must be employed.

3. Cellulitis and erysipelas. These grave complications are likely to set in when the patient is aged or much broken down in health, with impaired viscera, or when, owing to extensive removal of bone—*e.g.*, having to saw through the zygoma and loosen the outer wall of the orbit, the surgeon opens up deep planes of cellular tissue, which cannot, from the surroundings, be kept aseptic, most troublesome burrowing in the neck probably following. To cut cellulitis short, free scarification with small incisions should be made use of early so as to unload the parts, and abscesses should be opened at once.

4. Lung trouble. Broncho-pneumonia from inhaling septic matter is here, as after removal of the tongue, a decided risk. In this case, also, the treatment is mainly preventive, by using every endeavour to keep the wound sweet, by the means already given (pp. 307, 376).

5. Inflammation of the brain or its membranes.

Mr. Butlin (*loc. supra cit.*) has shown that the mortality after removal of the upper jaw is nearly 30 per cent.—a large mortality, equal to that of amputation of the thigh in the upper half (for disease), or perhaps exceeding it. He goes on to remark that, if we are to reduce this mortality, “we must adopt two courses in the after-treatment—first, such means as will render

the wounds aseptic ; second, regular and sufficient administration of food."

6. Recurrence.

With regard to this, Mr. Butlin considers the prospect as very gloomy, only four cases out of sixty-four (in which the result is recorded) being able to be considered successful—*i.e.*, having remained cured for three years.

OPERATIONS FOR NASO-PHARYNGEAL POLYPUS

(Figs. 93, 94).

Attachments and Relations.—The surgeon should consider these carefully before deciding what operation he will adopt for one of these most dangerous growths.

They will vary according to the duration of the polypus. The primary attachments of the growth start by far most frequently from the base of the skull, arising in the thick periosteum covered by mucous membrane which covers in the roof of the nose and top of the pharynx, especially the adjacent parts of the basi-sphenoid and basi-occipital. Less frequently they may arise in the pterygoid fossa and adjacent plates, or from around the posterior nares. Dr. Sands* points out that the region in which a naso-pharyngeal polypus can originate is one of narrow limits, corresponding with the margins of the posterior nares and the summit of the pharynx. It is thus one that can be satisfactorily explored with the finger, and by this means a polypus should be detected in its early stage and removed safely while yet small.

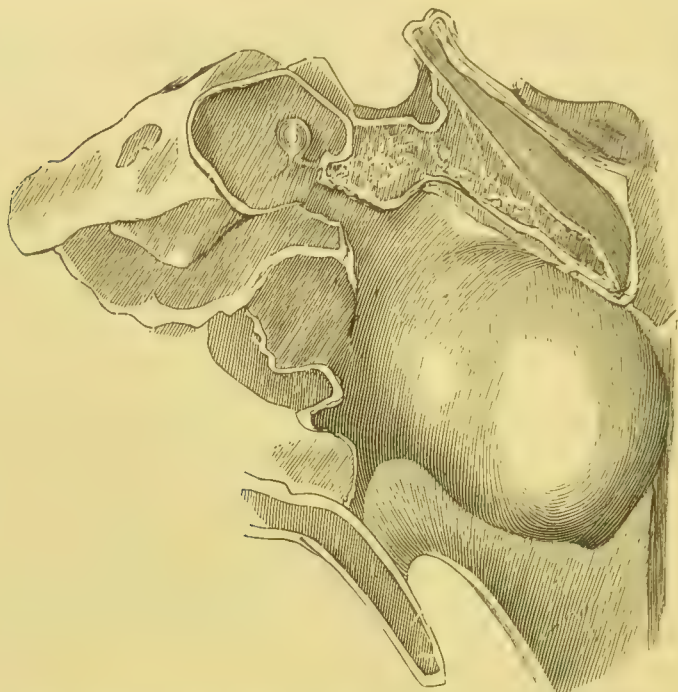
While the above are the most frequent *primary* attachments of the growths, it should always be remembered that when one of these polypi has existed for some time, when they are sloughy, when previous attempts have been made to remove them—under these conditions the growth is very likely to have taken on *secondary* attachments. A common instance of these is seen when a growth springing from the base of the skull forms adhesions to the pterygoid fossæ.

If secondary attachments are made out to exist, the next question will be, how far are these intimate and close? How far is the growth not only in contact with, but how far has it actually absorbed bones, such as those of the nose? How far has it got into the antrum, and thus come to resemble closely a growth of the upper jaw? It is obvious that if the growth is mainly limited to the nose, if the bones of this cavity are chiefly affected, it is through the nose that the polypus should be attacked. Again, swelling of the cheek, with protrusion of the eye, will point to an operation, osteoplastic or otherwise, on the upper jaw. In

* "On Naso-Pharyngeal Polypi": Dr. Brown Séquard's *Arch. of Sci. and Pract. Med.*, No. 6. According to Dr. Sands, these polypi may also spring from the apex of the petrous bone and the great wing of the sphenoid.

the same way extension of the growth into the zygomatic and temporal fossæ will render the prognosis unfavourable. Finally, any symptoms pointing to softening of the base of the skull and implication of the membranes—*e.g.*, headache, tendency to coma, convulsions, with evidence of pyrexia, will be conclusive against any operation, even when most carefully performed.

FIG. 93.



Naso-pharyngeal polypus springing from the base of the skull. In the sphenoidal sinus is seen a smaller polypus. (Massé.*)

Methods of Removal.—Amongst these are—

(i.) **Avulsion.**—In a few rare cases where the growth is small, where the pedicle is distinct and narrow, and where it not only can be reached, but also commanded (two different things), it may be torn away with suitably curved forceps introduced either by the nose or by the mouth, aided in either case by a finger passed behind the soft palate.

This method is only suitable to the above cases, and in none is it without danger. Mr. Cooper Forster's interesting case (*Clin. Soc. Trans.*, vol. iv. p. 159) is a striking instance of this.

Attempts having failed to remove the polypus with a wire loop, Mr. Forster introduced a pair of blunt-pointed strong forceps, and twisted off several large pieces, enough to fill the palm of the hand. These were very adherent, and required a great deal of force to detach them. There was much hæmorrhage. Severe headache quickly followed, then aphasia, restlessness, convulsions, and death on the twelfth day. General arachnitis was found, with sloughy softening of the brain, about Broca's convolution. The growth occupied the left side.

* *Thèse des Polypes naso-pharyngiens.* Paris, 1864.

filling the space between the greater and lesser wings of the sphenoid, the orbital plate of the frontal, and the cribriform plate of the ethmoid.* From the nasal fossæ it had extended by the sphenoidal fissure into the back of the orbit, but without damaging the optic nerve. The cribriform plate of the ethmoid was broken, there being a small opening at its back part from which a fracture extended forwards. This fracture had doubtless been effected while the growth was being torn away.

The serious hæmorrhage,† and the probable incompleteness of the operation, are also strongly against making use of avulsion. Here, as elsewhere, removal of malignant disease piecemeal is most unsatisfactory.

(ii.) **Ligature.**—This again is only suitable to very few cases—*e.g.*, where the pedicle is distinct and fairly thin, and where the growth has contracted no adhesions. In addition to the probability of return in the pedicle, the factor which accompanies the sloughing process is a most serious drawback.‡ If the ligature were to be used at all, every attempt should be made to get rid of the growth at the time by attaching the ligature after it is placed round the pedicle to a suitable *écraseur*, and so removing it. Care must be taken in such cases to prevent the growth, when the pedicle is divided, falling upon the larynx.

(iii.) **Galvanic Loop.**—In the very few cases where ligature can be tried, this modification would probably be the best. But even here the pedicle would be left, unless the surgeon possesses special instruments, such as the post-nasal galvano-cautery, and experience in using it.

(iv.) **Electrolysis.**—This method is both most tedious and uncertain. It can only be used as an auxiliary. Thus, Dr. Sands suggests that, after removal of the growth, its pedicle might be successfully treated by electrolysis.

Where patients are weakened by repeated bleeding, the hæmorrhage may be arrested by electrolysis, and the growth sufficiently reduced in size to allow of its being removed through the natural passages.

(v.) **Excision by an Operation involving Removal of Bone, Osteoplastic or otherwise.**—These may be divided as follows:

A. Those in which the attack is made by the mouth.

B. Those where the attack is made through the nose.

* It is noteworthy that though this large growth (Mr. Forster describes it as "an enormous mass around which it was impossible I could get the wire") thus extensively implicated the base of the skull, it only appeared externally as a firm, fleshy polypus filling up a large part of the left nostril, but apparently not pressing much upon the right one. There was no dilatation of any part of the face, no fulness of the palate, nor any projection in the throat.

† According to Dr. Sands, Dupuytren lost a case from hæmorrhage after an attempt to remove a polypus by forceps, in which he succeeded in removing only a few fragments. If this method is ever made use of, it might be wise to first perform laryngotomy, and plug the fauces with a sponge.

‡ Dr. Sands quotes other causes of death as not infrequent—*viz.*, suffocation from detachment of the growth, pyæmia, and œdema of the larynx.

C. Those by which the attack is made by removing the upper jaw, partially or completely, or by resecting this bone osteoplastically.

A. *Operation for Naso-pharyngeal Polypus through the Mouth* (Fig. 94).—This operation was strongly advocated by M. Nélaton. It consists in slitting the uvula and soft palate exactly in the middle line from before backwards, then prolonging this incision along the centre of the posterior half of the hard palate, going here down to the bone; from the end of this incision two others are made slightly obliquely outwards towards the teeth, also going down to the bone. The flaps, together with the periosteum, are then detached, so as to form nearly rectangular flaps.* Two large holes are then drilled through the hard palate, each well to one side of the middle line, the intervening bone is cut away by placing the ends of cutting-pliers in each of these holes, and, by making lateral cuts back to the free border of the hard palate, a rectangular portion of the posterior half of the bony vault is removed. The mucous membrane and the periosteum on the upper surface of the bone, which will now be found detached, are divided, and if needful to get more room, more or less of the vomer is cut away. Room being thus obtained, the polypus is removed and its pedicle dealt with. If all the growth is got away satisfactorily, the palate flaps are united in the ordinary way; if further treatment is required, staphylorrhaphy must be performed later.

The advantages of this operation, when contrasted with removal of the upper jaw, are at first sight considerable.

(1) There is no deformity left on the face; (2) the parts cut through are less important; (3) mastication is not interfered with by removal of the teeth; (4) the operation is less difficult; (5) the hæmorrhage is less,† no large vessels being cut through; (6) the growth is attacked directly; (7) through the gap thus left the surgeon can again attack the growth; within a few days, if he has been unable to complete the operation, or later on, if recurrence takes place; (8) the gap can easily be dealt with later on by staphylorrhaphy, or by wearing an obturator.

I am afraid that on closer examination the above will not bear

* This detachment is, as is well known in staphylorrhaphy, difficult posteriorly, at the junction of the palates, and is best effected by the raspatories (Fig. 118).

† This is very doubtful. Dr. Sands (*loc. supra cit.*), in removing a polypus by this method, had surrounded, without difficulty, the pedicle with an *écraseur-chain*. This breaking, the pedicle, which was stout and firm, was divided with scissors as close to the skull as possible. Copious hæmorrhage followed, and much time was consumed in unsuccessful attempts to secure a large artery which had retracted to the deepest part of the wound, and which was inaccessible to the ligature. The bleeding finally ceased, in consequence of the prostration of the patient, who had several alarming attacks of syncope. The growth recurring, it was removed by the method of Maisonneuve. Though it was not thought prudent to attempt the removal of a small prolongation which ran into the sphenoidal sinus, no recurrence had apparently taken place nine months later.

the only true test. The first three are no doubt of great value if the growth can be entirely dealt with by this method; otherwise, considering the malignancy of these growths, the inveterate way in which they recur, if incompletely dealt with, neither surgeon nor patient would be wise in running great risks for the sake of what one may call rather æsthetic advantages.* There is no doubt that, in a few cases, to be mentioned a little later, where the polypus is of moderate size, distinctly pedunculated, and attached low down, *e.g.*, about the posterior nares, or well forward on the base of the skull, the operation will be easier, the hæmorrhage will be less, and the growth will be more directly attacked. The advantage of a future staphylorrhaphy is, like those given first, not of sufficient value to recommend this operation if it is wanting in others more important.

Turning to the cases themselves, Dr. Robin Massé has collected twenty-six treated by this method, twelve having been under the hands of M. Nélaton himself. Of these twenty-six, thirteen are said to have been successful, but it is not stated for how long they were followed up. In one case, in which the after-history is given, a small recurrence took place two years later from the pedicle, and was destroyed. While suited to the cases mentioned above, the method could scarcely be made use of successfully in large polypi, in the case of those with secondary attachments or large sessile bases, or in the case of those which have extended into the pterygoid fossæ, or, in fact, beyond the naso-pharynx. Save by French surgeons, it does not appear to have been much used, from the belief that the space given is too limited.†

Dr. Sands points out that, in the majority of the cases in which surgeons have operated through the palate, they have had to leave the wound open in order to remove the pedicle later. This step is by no means as easy as might be imagined, and in many cases the surgeon has been driven later to make use of another operation when the patient's condition is less satisfactory. Furthermore, repeated irritation in the shape of attempts at destruction of the

* I may here draw attention to the great frequency of these polypi in males, in whom the growth of hair will largely conceal the facial deformity consequent on operations through the upper jaw. In young patients where the mouth is small and the growth large, this operation will be out of the question.

† Mr. Stonham (*Lancet*, January 7, 1888) has recorded a case of naso-pharyngeal polypus, in which "the soft palate was divided in the middle line, and an attempt made to remove the growth through the mouth; but this plan failing to give sufficient room, the nasal cavity was opened up," and the growth thus successfully removed. I have no experience of this operation myself, but I should expect that the bleeding, though from smaller vessels, might, owing to the confined space, and thus a more prolonged operation, almost equal that met with in operative attacks through the jaw, while the vicinity of the larynx makes any hæmorrhage here more embarrassing. Again, in those patients with narrow, highly arched palates, this operation would be accompanied with very great difficulty.

pedicle with caustics, the cautery, &c., is too likely to result in rapid sarcomatous growth.*

B. *Operation for Naso-pharyngeal Polypus through the Nose.*—
Under this heading will be included :

- | | |
|----------------------------------|-----------------------------|
| (1) Furneaux Jordan's operation. | (2) Rouge's operation. |
| (3) Lawrence's operation. | (4) Langenbeck's operation. |
| (5) Ollier's operation. | tion. |

These operations through the nose are only suited to cases in which the bulk of the polypus is nasal rather than pharyngeal, and in which its pedicle is attached to a point well within reach, as around the posterior nares—for cases, in short, the removal of which might perhaps be attempted, by the use of forceps, by the nose, but in which additional room is required. They may also be used in doubtful cases for exploratory purposes. For other cases, the room which they give, and the access which they afford to the tumour, will probably be found insufficient. Dr. Sands, in speaking of Langenbeck's operation (the only one which he mentions), says that he has found that, after the nasal bone and the nasal process of the superior maxilla have been removed, the distance of the basilar process of the occipital from the anterior opening is nearly 3 inches, and although the boundaries of the nasal fossæ would, in any given case, probably be dilated by the tumour, the space thus afforded would rarely be found sufficient for satisfactory dealing with the pedicle.†

(1) Furneaux Jordan's operation. I prefer this to any other by the nose. It is extremely simple, most efficient (especially when a growth has dilated the nasal cavities), and leaves most trifling scars. An incision like Sir W. Fergusson's being made along the side of the nose and through the lip, the nose is detached from the bone, and the septum, being cut through, is turned over on to the opposite side of the face.

(2) Rouge's operation. This has already been described at p. 295.

(3) Lawrence's operation.‡ In this, the back of the nasal cavity is exposed and got at by turning up the nose.

The integuments are first divided on each side of the nose by an incision beginning at a point just internal to the lachrymal sac, and carried down to the junction of the ala and the lip. Next, the incision is completed by cutting through the nasal bones and the nasal process of the superior maxilla with bone-forceps. The septum being now divided, the nose is turned up and the posterior part of the cavity exposed.

* Dr. Sands points out that the deep situation of the growth, and its position near the larynx, render the use of caustics both difficult and dangerous.

† M. Hergott (*Gaz. des Hôp.*, 1867, p. 97), in the case of a polypus recurrent after treatment by ligature, tried rasping the point of implantation on the base of the skull. He found that an instrument passed through the anterior nares impinged exactly upon this point; the bone was easily denuded, and seven months afterwards no trace of reproduction was visible.

‡ *Med. Times and Gaz.*, 1862, vol. ii. p. 491.

(4) Ollier's operation through the nose * (Fig. 125).

In this method the nose is, by an incision somewhat like the last, turned not up but downwards. M. Ollier begins his incision at the edge of the bone, close behind the ala of the nose, carries it upwards along its side to the highest part of the depression between the eyes, then across, down to the corresponding point on the other side. The bone is sawn through in the line of the incision, the necessary liberating incisions made in the septum and the sides, and the nose turned down. The septum is pressed aside, the polypus extracted, its base of implantation scraped, and the nose replaced.

A modification which is sometimes desirable on account of the size of the polypus, or the distance of its implantation, is indicated in Fig. 125. The incision is made obliquely outwards upon the cheek, and a transverse one is made from each end inwards to the ala of the nose. The bone is divided in the direction of the skin incisions—in the vertical one, as before described; in the horizontal one, by passing a fine saw across the nostrils, through holes made between the bone and cartilages, and sawing outwards. This line of section must be high enough to avoid the roots of the teeth.

C. *Operations for naso-pharyngeal polypus by removal of the upper jaw; (1) completely; (2) partially; or (3) by osteoplastic operation on this bone.*

(i.) *Complete Removal of the Upper Jaw.*—This has already been fully described (p. 304).

(ii.) *Partial Removal of the Upper Jaw.*—These operations are very numerous; one or two will be given as specimens.

a. *Method of Maisonneuve * and Guérin † (Fig. 94).*

Dr. Robin Massé (*loc. supra cit.*, p. 51) states that the so-called operation of Maisonneuve is really that of Guérin, with only a modification in the division of the soft parts. The essential point is to get room for attacking the polypus by removal of the lower part of the jaw. This bone being sufficiently exposed by raising the soft parts over it—and for this purpose the method of Sir W. Fergusson seems superior to those given by the above French surgeons—the hard and soft palate are then divided in the middle line, and the soft detached transversely on the side to be operated upon. The hard palate is next divided in the middle line by saw and bone-forceps, working from the nose into the mouth. By a transverse section with a narrow-bladed saw introduced into the nose, and made to cut horizontally outwards, the facial aspect of the bone is divided as far as the maxillary tuberosity.‡ The lower part of the jaw is then strongly depressed,

* I am indebted for the following brief account of M. Ollier's operation to Dr. Stimson's *Operative Surgery*, p. 185.

† *Gaz. des Hôp.*, 21 Août 1860.

‡ *Elém. Chir. Opér.*, 1858.

‡ This section should pass above the roots of the teeth and well below the infra-orbital foramen. Accurately speaking, it was mainly performed, in the hands of its introducers, with bone-forceps.

and thus detached, consisting of the alveolar and palatine processes, a portion of the body, and a varying amount of the pterygoid processes which usually comes away with it. The polypus is then extirpated.*

b. Method of M. Béraud.

In this the upper, not the lower, part of the jaw is removed, so as to preserve intact the teeth and alveolar process of the palate.

In all these operations hæmorrhage may have to be met by a preliminary laryngotomy and plugging the top of the pharynx (pp. 366, 384); and also, perhaps, by a temporary ligature of the carotid (pp. 485, 492). Afterwards it will be advisable to plug the

FIG. 94.



The dotted lines show Maisonnewe's operation, the two continuous ones that of Langenbeck's osteoplastic operation on the jaw. On the hard palate are the lines of Nélaton's operation. Trephining the frontal sinuses is indicated above.

cavity firmly with strips of iodoform gauze wrung out of carbolic acid lotion (1 in 20).

(iii.) *Osteoplastic Operations on the Upper Jaw.*—In this the bone is cut through by various incisions, turned in different directions on some uncut attachments, as on a hinge, and then fitted down again after the removal of the growth.

Method of Prof. Langenbeck† (Fig. 94).—This is one of the best known of the above operations. Its object is to get at the polypus, especially one in the pterygo-maxillary fossa, without interfering with the alveolar and palatine processes or with the orbital plate. While this operation seems well suited to its object, its drawbacks seem to be great, for (1) there is the great

* Dr. Sands appends to his paper a photograph of the patient on whom he had operated by this method, after failing to remove the polypus by the plan of M. Nélaton. The deformity is very slight, the malar prominence and the fulness of the cheek being well preserved.

† *Deuts. Klin.*, 1861, p. 281; and Schmidt's *Jahrb.*, Bd. cxiii. p. 198.

difficulty of raising so fixed a bone, and again of getting it evenly into place; (2) if the upper jaw has to be sawn from behind forwards, this cannot be done easily unless the fossæ at the back of the jaw and the speno-palatine foramen are much dilated; (3) if the growth has extended into the naso-pharynx, this region will not be well exposed; (4) very disfiguring scars are left.

Two semilunar incisions, with their convexities downwards, are made across the facial aspect of the upper jaw, the lower running from the ala of the nose to the middle of the malar bone, the second starting from the nasal process of the frontal and passing just below the orbit to meet the first, where this ended. If needful, owing to the extension of growths backwards, the meeting of these incisions may be carried back along the zygoma. Each cut is made down to the bone, but the skin is not reflected. At the outer end of the lower one the masseter is detached from the zygoma, and if the growth has extended out into the zygomatic fossæ it will now come into view on dividing the buccal fascia. Prof. Langenbeck found at this stage that by pressing the growth to one side and depressing the lower jaw he could pass his finger through the pterygo-maxillary fissure into the speno-maxillary fossa, and so on through the speno-palatine foramen into the nose, all these parts being enlarged by the pressure of the growth. By means of a narrow straight saw introduced the same way the upper jaw was cut through horizontally from behind forwards, while a forefinger passed by the mouth kept the tip of the saw from striking against the septum nasi. The saw was now applied along the upper incision so as to divide the zygoma, the frontal process of the malar, and the upper jaw, just below the orbit, up to the inner end of the incision. The portion of the upper jaw thus marked out now only remain attached, at its inner part, to the nasal bone and nasal process of the frontal. Upon these connections, as upon a hinge, the piece of bone was slowly raised by means of an elevator introduced under the malar bone, upwards and inwards, until the malar bone was nearly in the middle of the face. The growth was now completely exposed. The operation took an hour, and was attended with much hæmorrhage, most of which stopped spontaneously. The wounds healed well, a tendency of the bone to rise being met by pressure.

At the present time any surgeon making use of the above operation would wire the bone when fitted down. I would suggest, too, that the incisions through the bones might perhaps, be more easily made with an osteotome and mallet, especially in cases where, the deep parts at the back of the jaw not being so much dilated as in Prof. Langenbeck's case, it is difficult to manipulate a saw and to cut from behind forward.

Prof. Langenbeck's patient was a lad of fifteen. The growth could be felt by the finger in the mouth, filling up the posterior nares on the left side, passing out between the masseter and maxilla; and on this side, too, the zygoma appeared more prominent, and the temporal fossa more full.

The Choice of an Operation for Removal of Naso-pharyngeal Polypus.—The relative values of several of the above operations have already been briefly given. The surgeon will have to weigh duly the following: On the one hand, the desire to get the growth away with as little mutilation and danger to his patient as possible, and, on the other, the fact that these growths are most certainly malignant in nature, and that any partial operation, while probably as difficult and as bloody as one on a larger scale, will, if incomplete, be certain to lead to increased growth in the tumour by the irritation which it causes.

For naso-pharyngeal polypi which come early under treatment, in which the growth is of moderate size (*i.e.*, not larger than a hen's egg), with a pedicle situated well forward in the roof of the pharynx or within easy reach from the posterior nares, especially polypi which can be made out to occupy chiefly the region of the nose, such operations as those of Furneaux Jordan or Lawrence may be made use of.

In cases of greater difficulty, from the longer duration, more extensive attachments, larger size, and with this last, the certainty of a more extensive pedicle and numerous large sinus-like vessels, the question of deformity and disfigurement must be entirely set aside.* In order to secure adequate space for making certain of all the attachments of the tumour, for eradicating these, and, at the same time, satisfactorily meeting the hæmorrhage which is usually inevitable, a freer removal of bone will be required. No doubt, for this purpose, partial or complete removal of the upper jaw would be the best preliminary step. Every surgeon who has performed this operation knows how free is the access which it gives to the back of the nose and to the pharynx. A further advantage, pointed out by Dr. Sands, is the following. that, owing to the wide gap left by this operation, recurrence of the disease can be more readily recognised and treated than after any osteoplastic operation.

But while willingly admitting the great advantages which removal of the upper jaw gives for free exposure of the growth, I cannot quite agree with Dr. Sands, who recommends this step on the ground that "excisions of the upper jaw are, as a class, remarkably successful operations." On the contrary, I should look upon this as a distinctly serious and grave operation (p. 308), especially in patients who, though young, often come before the surgeon with strength reduced by hæmorrhages, dysphagia, and dyspnœa, especially when this is accompanied by attacks of choking interfering with sleep, &c. Any one in doubt whether to get at the growth by some partial resection of this bone, as by the method of Maisonneuve, aided, if needful, by cutting away the pterygoid process and septum,† or to make use of an osteoplastic operation, must remember that the tempting nature of the latter must never weigh too much with the surgeon, especially in cases where rapidity is of great importance, in a patient much pulled down, or where every atom of additional space is required to deal with the base of the growth, or to command serious hæmorrhage. Finally, the operator will do well to be guided not so much by the set operations of other surgeons, but by what he meets in his own case.

* I may again remind the reader that these naso-pharyngeal polypi usually occur in males, often in lads or young adults. The growth of hair which can usually be secured in these cases lessens, to a considerable degree, the amount of disfigurement which operations on a larger scale entail.

† So as to expose completely any outlying attachments in the pterygoid and zygomatic fossæ, and to get full access to the pharynx and nose.

Dangers and Drawbacks of Osteoplastic and other Operations for Naso-pharyngeal Polypus.—Many of these have been already given under the head of removal of the upper jaw (p. 308); other ones, more particularly to be expected here, are:

1. Hæmorrhage, not from large arteries, as the internal maxillary, but from the sinus-like veins in the growth itself. To meet this inevitable risk a preliminary laryngotomy should be performed, and the fauces plugged with sponge (pp. 366, 384).
2. Meningitis, from damage to the base of the skull (p. 310), or from inflammation spreading to the membranes of the brain.
3. Necrosis and exfoliation.
4. Non-union of a temporarily resected fragment.

TAPPING THE ANTRUM.

This operation is from time to time required for suppuration in the antrum, nearly always in adults, and most frequently after alveolar abscess.

It may be performed in either of the following ways:
(i.) Through the alveolar process. (ii.) Through the facial aspect of the upper jaw, above the alveolar process.

(i.) *Through the Alveolar Process.*—This method has the following advantages: (α) It drains the cavity at the most dependent part. (β) By withdrawal of the tooth it removes the cause of the trouble. (γ) It does not involve any cutting.

The disadvantage connected with this method, is, that, unless special precautions are taken, food tends to enter the antral cavity by the opening made by this method.

A tooth has usually to be first drawn, and, as long ago pointed out by Mr. Salter (*Syst. of Surg.*, vol. ii. p. 467), "the tooth whose fangs are most intimately connected with the antrum is the first permanent molar,* and its removal in a case of antral abscess is especially indicated from this circumstance, and from the frail and perishable nature of the tooth itself, which gives it less often than other teeth a long tenure of usefulness." This being done, the orifice made should be enlarged by pushing a trocar, or better, a drill or gimlet up through the alveolus. Whatever instruments are used should be of sufficient size to ensure a free orifice, and, in driving them up through the bone, care should be taken that, when they enter the antrum, they should not plunge against and perforate the orbital plate. The opening, when made, is best widened by a "rat's-tail file."

(ii.) *Above the Alveolar Process.*—If the offending tooth has already been extracted, perhaps a long time before, if the alveolar process is largely absorbed, or its remains condensed, it will be

* Any other tooth, as Mr. Salter advises, molar, bicuspid, or canine, whose disease is possibly the cause of the abscess, will, of course, be extracted, as absorption round any carious tooth facilitates perforation of the alveolus.

preferable to make the opening above. This may be effected by everting the cheek, incising the mucous membrane, and thus exposing the bone above the position of the second molar tooth, and then perforating here with a gimlet or drill, and completing it in the way advised above.

Where the bone is much condensed, the instrument used in perforating will be held so tightly that the surgeon will need to withdraw it once or twice and use a probe before he can make certain of having opened the antrum. The opening should be as large as an ordinary wooden lead-pencil, and should be kept midway between the two alveolar plates.

The antrum having been opened by one of the above methods, the chief objects are, getting and keeping sweet the cavity of the antrum and preventing any food making its way in here, while at the same time the artificial opening is kept patent.

To ensure these ends frequent syringing through a bit of gum-elastic catheter must be made use of, the lotion used being mercury perchloride, carbolic acid, iodine tincture, potassium permanganate—the lotion itself not being of so much importance as the assiduous frequency with which it is used. After a while, when the discharge is no longer offensive, and no inspissated putty-like stuff comes away, some such astringent as silver nitrate (gr. 1 or 2— Zj) may be used.*

To prevent the entrance of food, and at the same time to keep the opening patent, a short tube should be worn, let into a plate fitted over the perforation. Through this tube the patient can readily syringe out the cavity by an antrum-syringe with flexible tubing attached, and by the insertion of a small cork, wood or metal pin, the entrance of food can easily be prevented. When there is no longer any need to keep the artificial opening patent, removal of the short tube and plugging the hole which held it will facilitate, by excluding air, saliva, &c., the closure of the antral opening. If this is still tardy, it may be hastened by the careful application of the cautery.

In a few very obstinate cases, as recommended by Mr. Newland Pedley (*Guy's Hosp. Recs.* 1894) a free permanent opening may be required.

REMOVAL OF THE LOWER JAW, PARTIAL OR COMPLETE.

Indications.—These are much the same as those already fully given for removal of the upper jaw (p. 299). Mr. Butlin (*Oper. Treat. of Malig. Dis.*, p. 137) has treated of these growths, and has pointed out that here important differences are observable between the central and sub-periosteal sarcomata.

* The patient should be warned at the commencement how very tedious these cases are, and told of the need of persevering and patiently prolonged treatment.

Thus the central (most often myeloid) sarcomata grow slowly, the sub-periosteal quickly; the former are encapsuled, and even when they make their way into the surrounding structures they do not show that tendency to infiltration which is so marked in the sub-periosteal sarcomata. The central ones are rarely associated with affection of the lymphatic glands, or with secondary growths.

The following operations will be considered:

A. Partial removal of the lower jaw.

B. Complete removal of one-half of the lower jaw (Fig. 95).

C. Complete removal of the jaws, upper or lower.

A. Partial Removal of the Lower Jaw.—This is frequently required in the case of epulis. The steps are the same as those given already at p. 299. The alveolar border should always be removed; in the case of a growth very far back around the lower molars it is quite justifiable to slit the cheek, especially if the growth is becoming doubtful in character, and thus requires thorough extirpation.

The above remarks still more hold good in the case of a growth about the gums, situated far back in an older patient, and becoming epitheliomatous.

Cases are occasionally met with where, owing to an epithelioma of the lip not having been treated, or to its recurrence, the symphysis of the jaw is infiltrated and requires removal. The soft parts being reflected by incisions on either side of the diseased parts converging towards the hyoid bone, and the vessels secured, the bone is sawn through in two places* well beyond the level, where its softened, spongy state, and the loosened teeth, show that it is invaded. The tongue, prevented from falling back by a loop of silk passed through its tip, is now detached by snipping through the mucous membrane, and the muscles attached to the genial tubercles. Any further hæmorrhage being looked to, the sub-lingual and sub-maxillary glands are examined, and, together with any enlarged lymphatic glands, removed if needful; flaps are dissected up from the neck to make a new lip (p. 343, Figs. 110, 111); and drainage provided, the tubes being brought out below at the lowest level of the region from which the flaps have been dissected up. The adjustment of these to form the new lip will be the more easy in proportion to the amount of bone removed.

So, too, occasionally in epithelioma of the angle of the jaw, primary, or secondary to that of the tongue, the surgeon may be led, in order to relieve his patient's condition, if he cannot cure him, to operate extensively here. Thus, after turning up a horse-shoe-shaped flap, with the concavity upwards, and clearing the

* Mr. Heath (*Dict. of Surg.*, vol. i. p. 839) gives the following practical hint with reference to dividing the jaw in two places:—"In making these sections it is better not to complete one before the other is begun, because of the loss of resistance consequent upon breaking the continuity of the bone, but each cut being carried nearly through the bone with the saw may be conveniently finished with the bone-forceps."

masseter off the jaw, this bone is divided above the angle, then through the horizontal ramus, and removed, together with the sub-maxillary, sub-lingual, and lymphatic glands, which will probably be enlarged, and also adherent. The hæmorrhage will be free from the facial and lingual vessels, and veins communicating with the external jugular. Free drainage must be provided.

Removal of part of the horizontal ramus or of the angle may be called for in cases of new growths limited to these parts, and the surgeon may, especially in the case of women, ask how far it is worth while to try and remove these from the mouth, detaching the soft parts with a raspatory, and sawing the bone in front and behind the growth, as in the case of an epulis, but the section here passing through the whole thickness of the jaw. Mr. Maunder on two occasions removed large portions of the bone in this way. The following remarks of Mr. Heath (*Dict. of Surg.*, vol. i. p. 837) should be carefully considered before the surgeon, for the sake of saving a scar which will be but little noticed, undertakes a much more difficult operation, and one which, owing to the limited space it gives, may tend to his working dangerously near the growth: "The principal difficulty in these operations was not so much the separation of the tumour, as its 'delivery' through the mouth, which was slightly split in one instance. Fortunately the hæmorrhage in both cases was slight, and the patients did well; but another surgeon was less fortunate, and lost his patient by secondary hæmorrhage, but considering the close proximity of the facial artery, and the necessary division of the inferior dental artery, this is not to be wondered at. It may be doubted if the extra trouble and risk of the proceeding are balanced by the absence of a scar, which, in the majority of cases, need not involve the lip, and if properly placed, will be nearly invisible afterwards."

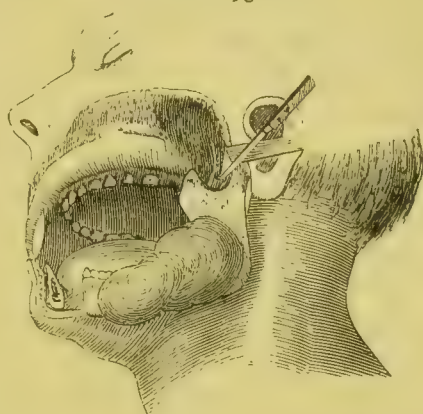
Question of removing a Portion or the Whole of one Lower Jaw.—This matter will have to be decided when the surgeon, having a case of growth before him which involves the horizontal ramus as far back as the angle, is in doubt as to whether to saw through the vertical ramus or to disarticulate. In the great majority of cases, especially where the patient is no longer young, where the growth is not a central one, where it has been attacked before, the operator had much best place his patient and himself on the safe side and disarticulate. The lower jaw being "a floating bone" this radical step often gives a better prognosis for operation here than in the case of the upper jaw. On the other hand, the lower jaw is so embedded in soft parts, and so near to important parts—*e.g.*, pharynx and pterygoid fossæ—that delay may render the extirpation of the growth impossible. I would refer my readers to two cases in which, after partial operations in Mr. Heath's hands (Hunt. Lects., *Brit. Med. Journ.*, June 18 and July 2, 1887), fatal extension and recurrence of the growth took place.

B. Removal of Half of the Lower Jaw (Fig. 95).—The

patient's shoulders being supported, and a preliminary laryngotomy performed if the growth is so vascular as to make plugging of the fauces a wise precaution, the surgeon, standing usually on the same side, makes an incision from just below the lip * down through the tissues on the side of the chin, then along and below the border of the lower jaw to the angle, and then up to a little below the lobule of the ear. The finger of an assistant is placed on the facial artery as soon as it is cut in this incision, and when it is completed the ends should be tied or twisted at once. The flap thus marked out is raised upwards, the masseter going with it if sound, and the cavity of the mouth opened by dividing the buccal mucous membrane at its junction with the alveolar border.

An incisor being extracted if needful, the jaw is divided to one side of the symphysis well in front of the growth, by means of deeply notching it with the saw † before using the bone-forceps. If it be needful to remove the bone so freely that the symphysis and the genial tubercles are removed also, the tongue must be carefully prevented from falling back upon the larynx by means of a loop of stout silk passed through the tip. The bone being divided and pulled out-

FIG. 95.



wards the knife is passed along the inner side of the jaw so as to detach the mylo-hyoid, with perhaps the digastric and the mucous membrane, and, at the angle, the internal pterygoid. In doing this the knife should be kept very close to the bone so as to leave behind the sub-maxillary gland.

The anterior half of the jaw being thus freed, the surgeon, taking it in his left hand, everts it so as to divide the internal pterygoid more freely, and also the inferior dental nerve and vessels. The jaw is next strongly depressed so as to bring down the coronoid process, and the insertion of the temporal muscle. This strong tendon requires complete division, as depression of the bone brings fasciculus after fasciculus into view. If the coronoid process is very long it may hitch against the malar bone or be jammed against it by the bulk of the tumour: in such case it had better be cut off with bone-forceps, and, after the removal of the

* If there are reasons for especial speed, such as the condition of the patient, or if the growth is very large, the red border should be divided, as this facilitates matters much, and the additional deformity is very slight.

† When the condition of things admits of it, the jaw should always be divided as far from the symphysis as possible, in order to preserve the anterior belly of the digastric and its insertion, which will thus counteract the tendency of the muscles on the opposite side to draw the chin somewhat over. It is convenient to be provided with a saw with a movable back.

growth, dragged down with sequestrum-forceps and removed. After the temporal tendon is thoroughly detached (when this is effected the jaw comes down more easily), strong depression of the jaw is continued so as to bring the condyle within reach, no eversion or rotation outwards of the bone being permissible at this stage of the operation, or the internal maxillary artery which passes between the neck of the jaw and the internal lateral ligament will be brought into the wound, and very likely cut, causing troublesome hæmorrhage. The inferior dental nerve and vessels being divided, and the external pterygoid fibres partly torn through with the finger or the director, the capsular ligament is opened in front with the careful use of the point of the knife, which next, kept close to the bone, divides the lateral ligaments, when the jaw comes away, the final separation being usually effected by the remaining fibres of the external pterygoid being torn through, together with the stylo-maxillary ligament and the periosteum to which it is attached. The knife, if it is required here, should be kept very closely in contact with the posterior border of the ascending ramus.

If the internal maxillary artery has been divided, which is sometimes excusable in cases of large growths extending far up, it can be readily secured in the large wound.

If the operator finds the vertical part of his incision insufficient, and yet does not like to prolong it for fear of damaging the chief part of the seventh nerve, the soft parts should be forcibly dragged upwards with a retractor, after being pushed upwards with the handle of the scalpel.

In cases where the jaw has been extensively thinned or eroded by growth it is very likely to fracture under the depression which is required to bring down the condyle. If this accident occur, removal of the condyle and coronoid process is rendered difficult, as the latter is drawn upwards under the zygoma by the temporal muscle. Their removal will be facilitated by dragging them down with lion-forceps and detaching the temporal tendon with blunt-pointed scissors. If the growth is wedged in firmly above the soft palate, the chief mass should be removed by cutting through the upper part of it, and sawing through the ramus just below the coronoid process. The part of the jaw thus left is then disarticulated, and the rest of the growth removed.

All hæmorrhage being arrested by ligature or sponge-pressure, any enlarged glands, including the sub-maxillary if affected, are removed. The flap is then brought down and adjusted with one or two points of silver suture and sutures of horsehair, gut, or carbolised silk, drainage being first provided for by bringing a drainage-tube from the neighbourhood of the condyle through the wound below. Iodoform with collodion is then brushed over the wound.

Especial care must be taken in exactly uniting the red line of the lip if this has been divided.

The wound is then dressed, as at p. 306, and the patient here

also should be propped up to facilitate escape of the discharges. For the first few days it may be well to feed by a nasal tube, or by rectal enemata and suppositories. The patient should wash his mouth out, as frequently as possible, as directed at p. 376.

In order to prevent the deformity which follows on this operation, especially in women, the surgeon should, with the help of a dentist, make use of the inter-dental splint and spiral wire spring of Dr. MacBurney of New York (*Annals of Surgery*, July 1894).

Difficulties and Possible Mistakes during the Operation.

(1) Slipping back of the tongue, if the symphysis has been removed. (2) Wound of the pharynx by not keeping the knife close to the bone in separating the soft parts from the angle of the jaw. This interferes with the patient's being able to swallow from the very first. (3) Fracture of the jaw. (4) Jamming of the coronoid process. (5) Rigidity and permanent contraction of the temporal, masseter, &c. (6) Wound of the internal maxillary vessels. (7) Outlying growth in the temporal region, or near to the tonsil and large vessels.

C. Operations for Complete Removal of Both Jaws.*

Before leaving the subject of removal of the jaws, a few words may be said of those rare cases which occasionally call for removal of both the upper, or the whole of the lower jaw, or both the jaws on the one side.† My space does not admit of my doing more than giving brief references to a few cases.

The growths which call for removal of both upper jaws, simultaneously, fall mainly under the two heads—(a) Epithelioma of the palate and alveoli involving one or both of the antra;‡ (β) Growths, usually sarcomatous, springing often from the base of the skull or some part of the naso-pharynx, and projecting forwards the jaws with hideous deformity.§ These cases are much less favourable than the epitheliomata.

In either case the parts are exposed by slitting the centre of the upper lip and then carrying the incision round the nose on either side, Fergusson's incision being made use of as far as needful. In a few cases, in order to get adequate room, it may be needful to make incisions from the angles of the mouth to the

* It is not always easy to tell the limits of a jaw-growth. Thus one of these may extend up to the level of the lower part of the ear, bulge forwards close up to the nose, creep low down in the neck, and yet originate in the lower jaw. In deciding to which jaw a growth belongs, attention should be paid to involvement of the floor or roof of the mouth, and the results of masticatory movements.

† Mr. Spanton (*Brit. Med. Journ.*, 1885, vol. ii. p. 64) records a case in which first the upper and a few months later the lower jaw on the right side became the seat of malignant disease. The jaws were removed at an interval of a week. The patient, aged fifty-five, recovered from the operations, but the lower growth quickly recurred.

‡ Godlee, *Clin. Soc. Trans.*, vol. xx. p. 260.

§ J. Lane, *Lancet*, January 25, 1862; Dobson, *Brit. Med. Journ.*, October 11, 1873.

malar bones, and raise all the intermediate soft parts as a flap. Wherever it is feasible, as in cases where the growth has begun in the alveolar processes, the infra-orbital plates should be retained. This may be done by sawing through both bones from the nose outwards, and completing the separation of the lower part of the maxillæ from the upper by an osteotome or chisel. After the full account already given of removal of the upper jaw no description need be given of these operations for removal of both halves simultaneously. The greater risk of shock, the liability to more profuse hæmorrhage, the probability of finding the growth extending far back into the different fossæ, and along the base of the skull, are obvious. Later on, if the patient make a good recovery, the help of a dentist will be much needed in fitting some form of obturator, as articulation is now much more imperfect,

Question of Gouging, &c., in preference to Partial Removal of the Jaw.

The treatment of dentigerous cysts, if simply cystic and uncomplicated by growth, by measures short of removal of part of the jaw, has already been given (p. 301). Treatment on the same lines—viz., extraction of teeth, freely opening up the cyst by cutting away part of its walls, turning out its contents, and then obliterating it thoroughly by vigorous gouging wide of the disease—has been tried in other cases, especially in those cases of cystic disease, more common in the lower than in the upper jaw, the multilocular variety of which has been called by Mr. Eve “cystic epithelial tumours.” This so-called “enucleation” should be adopted with the greatest caution. In young patients with cysts and fluid contents and no intra-cystic growth the above method is permissible, as it leaves no deformity. These cases will always require careful watching afterwards. Where there is any solid growth, neither gouging nor enucleation is permissible.* Their use is to be condemned in the strongest terms in anything approaching to the periosteal sarcoma.†

* Mr. Lawson brought before the Clinical Society (*Trans.*, vol. vi. p. 20) the case of a man, aged sixty-five, in which he succeeded, by excision and application of zinc-chloride paste, in removing an epitheliomatous growth of the upper jaw fungating through the skin of the face. The growth recurred twice during convalescence, and on each occasion an anæsthetic was given, and the actual cautery and the zinc-chloride paste applied. Mr. Lawson points out—(1) that patients advanced in life stand large cutting operations, such as the complete removal of the upper jaw, very badly, whilst they will bear with but little shock the destruction of large growths by escharotics; (2) that the treatment was accompanied with very little pain; (3) that the deformity produced by such an operation is much less than that after an equally efficient operation by the knife which would have involved cutting widely of the growth. It is to be regretted that no details are given of how the growth was excised, nor of how much of the bone was removed. Furthermore, the report is only carried on four months after the patient's leaving the hospital.

† An instructive case of sub-periosteal sarcoma which was three times treated by gouging—rapidly recurring each time—and twice by removal of parts of the

OPERATIONS TO RELIEVE FIXITY OF THE LOWER JAW (Fig. 96).

SUTURE OF DISPLACED FIBRO-CARTILAGE.

The above condition may be due either to changes in the temporo-maxillary articulation resulting in ankylosis, or to cicatricial bands between the jaws, or to both.

Operations.—The two usually performed are:

(i.) Excision of the condyle, an operation indicated when the mischief is limited to the joint itself.

(ii.) Esmarch's operation of removing a wedge of bone from the horizontal ramus in front of the cicatrices and masseter, this operation being preferable to the first when scars are present which interfere with excision of the condyle.

Conditions justifying One of the above Operations.—Inability to open the mouth, resisting use of wedges, &c.* Foetor of saliva and breath. Difficulty of speech. Inability to eat solid food. The above are brought about by the following causes, which will be enumerated together here, though some call for one of the above operations and some for the other—viz.:

1. Inflammation of the joint set up by a punctured wound,† gonorrhœal arthritis, severe contusion‡ or sprain, osteo-arthritis,§ or suppurative arthritis, from abscesses burrowing into the joint, e.g., abscesses connected with otitis media. 2. An unreduced dislocation in which much stiffness remains after attempts at reductions have failed in a patient healthy and not advanced in life. 3. Cicatrices after sloughing set up by scarlet fever, measles, typhus, cancrum oris, or mercurial stomatitis. 4. Cicatrices after suppuration due to necrosis or alveolar abscess. 5. Periostitis of malar after suppuration, fixing the condyle to the inner surface of the zygoma (Heath, *Brit. Med. Journ.*, 1884, vol. ii. p. 1191).

Excision of the Condyle (Fig. 96).—This operation is jaw, is given in the *Lancet*, 1889, vol. ii. p. 1168. Death took place from a recurrence in the floor of the mouth within seven months of the first operation. Those familiar with surgical literature will recall many similar cases.

* Mechanical apparatus must be used early to do any good. Daily forcible use of levers is usually unsatisfactory, and the use of interdental shields can do little more than retard scar-formation.

† Cf. Mr. Hilton's case (*Rest and Pain*, p. 114), in which bony ankylosis of this joint, and of the upper cervical vertebræ, seemed to date to a punctured wound in the neck.

‡ Mr. Heath (*R.C.S. Lects*, 1887, vol. ii. p. 114) mentions a case in which ankylosis of the temporo-maxillary joint followed on a kick from a horse on the side of the face. In such cases a fracture may co-exist.

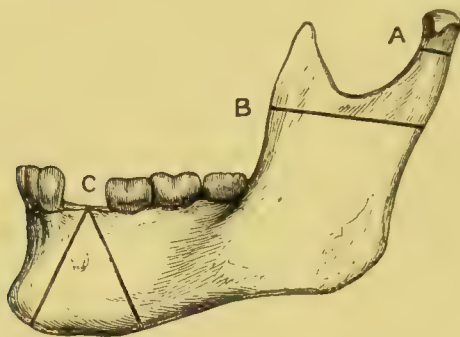
§ Good illustrations of this condition are given by Mr. Heath (*Brit. Med. Journ.*, 1887, vol. ii. p. 55). The fibro- and articular cartilages will probably be wanting. See also Prof. Humphry's case, *A Report of Some Cases of Operation*, pamph., 1856.

indicated when the mischief is limited to the joint itself, as in the first two conditions given above.

It may be performed as follows:

An incision about $1\frac{1}{2}$ inch long is made on a level with the tragus along the lower border of the zygoma. The parotid and branches of the facial nerve being drawn down, the masseter fibres are cleared away from their insertion with a narrow elevator, and the joint exposed. The neck of the condyle is now sawn through with a fine saw, or divided with an osteotome, and the condyle turned out with an elevator, the external pterygoid being detached. The fibro-cartilage is left behind. The bone, which must not be splintered, may require further paring down, and the operation need repeating on the opposite side

FIG. 96.



A, Excision of condyle. B, Excision of coronoid and condyloid process. C, Esmarch's operation. This must always be in front of all cicatrix-tissue. It happens to correspond here to an edentulous part of the jaw.

before sufficiently free movement is regained. After the operation the mouth should be opened with a gag to a full inch, more if possible, and this should be frequently repeated with the aid of nitrous oxide or ether, and the case watched most carefully owing to the frequency with which relapses take place.

In severer cases it will be advisable to remove the coronoid process as well, and thus leave a wider gap. Dr. Mears (*Amer. Journ. Med. Sci.*, 1883, p. 459) considers that this method has the advantages of being applicable to all cases, and of giving better results, and I entirely agree with him from my experience of it in one case in which the result was excellent. A little facial paralysis, usually temporary, is often present after removal of the condyle. After more extensive interference with the soft parts, there is a greater risk of its being permanent. After operations here, the best dressing will be iodoform gauze wrung out of carbolic-acid lotion (1 in 20), and sal alembroth wool, or hot boracic lotion and boracic-acid lint with a little iodoform, frequently renewed. To prevent recurrence of the stiffness, every means should be taken to ensure asepsis of the wound throughout.

If hæmorrhage occur, plugging with aseptic gauze must be made use of.

Esmarch's Operation (Fig. 96).—Where the fixity is brought about by cicatrices within the mouth rather than by mischief limited to the joint, removal of a wedge-like piece of bone, in front of all scars, is to be preferred. Division of the bands inside the mouth is absolutely futile, and attempts to cover the wounds, made by excision of scars, with flaps of mucous membrane or skin are difficult, bloody, and disappointing.

An incision 2 or $2\frac{1}{4}$ inches long is made along the lower border of the jaw in front of the masseter and cicatrices. This incision should go down to the bone: the facial artery will probably need securing. A triangular wedge of bone is then removed with a narrow saw and bone-forceps. The sections should be made as cleanly as possible to avoid risk of necrosis, and the periosteum should be removed with the bone. The wedge should measure at least $1\frac{1}{4}$ inch below and $\frac{3}{4}$ inch above,* and it must be taken from a part entirely in front of any cicatricial tissue.

If possible, its apex should correspond to an edentulous gap in the alveolar process. If the dental artery bleed freely, a heated wire must be applied, or the triangular gap plugged with strips of aseptic gauze.

Owing to the tendency to relapse,† passive and active movement should be made use of early, and, at first, if needful, with the aid of an anæsthetic.

The operation should be performed early in cases where cicatrization after severe ulceration is leading to increasing fixity of the jaw, ultimately needing operative interference.

Mr. Heath‡ thus states his opinion of Esmarch's operation: It is "a comparatively easy proceeding; and in cases where only one side of the jaw is affected, restores the patient a very useful, though one-sided, amount of masticatory power in two or three weeks, and with very little suffering or annoyance. One side of the jaw is, however, rendered permanently useless (its previous condition), and there is a necessarily resulting deformity, which is not, however, of a very distressing character. The paralysis, from the division of the nerve, is so slight as not to be worthy of mention."

Suturing of Displaced Inter-articular Fibro-cartilage.—Where

* In two of Mr. Heath's cases the wedge removed included the mental foramen.

† This relapse is more likely if the wedge is not removed well in front of all cicatrices. Thus, Mr. Heath (*Dis. and Inj. of the Jaws*, p. 332) found, two years after Esmarch's operation for complete closure of the jaws, that the interval between the left molars had diminished from $\frac{7}{8}$ to $\frac{1}{8}$ inch, and that between the lateral incisors from $\frac{5}{8}$ to $\frac{2}{8}$ inch. Mr. Heath thought that in this case he had not been sufficiently careful to make the bone section entirely in front of the cicatrices.

‡ *Loc. supra cit.*, p. 338.

sub-luxation of the cartilage does not yield, as it usually will, to blistering, tonics, &c., and troublesome clicking and catching of the jaw persist, Prof. Annandale has twice successfully operated as follows (*Lancet*, 1887, vol. i. p. 411): An incision about $\frac{3}{4}$ inch long is made over the posterior margin of the external lateral ligament, and carried down to the capsule. Bleeding being stopped, the capsule is opened, and the fibro-cartilage seized and drawn into position, and secured by catgut to the periosteum and other tissues at the outer margin of the joint.

CHAPTER VIII.

OPERATIONS ON THE LIPS.

HARE-LIP AND OTHER PLASTIC OPERATIONS ON THE LIPS.

HARE-LIP (Figs. 97 to 109).

Best Time for Operation.—Any time after the second or third month. For most cases the third to the sixth month is the best. All should be over by the seventh month, when dentition begins.

With regard to operations at an earlier or later date than the above, it is interesting to note what Sir W. Fergusson, whose experience was unrivalled, advocated with a riper experience. Thus, in his *Practical Surgery* (4th ed. p. 573, 1857), he wrote: "I have myself operated very frequently within the first three weeks;" and a little later, "From all my reflections and experience on the question, I am more than ever disposed to recommend a very early operation." In his *Royal College of Surgeons Lectures on the Progress of Anatomy and Surgery* (1867), with an experience of between 300 and 400 cases, he wrote: "I decidedly prefer about the end of the first month." Writing later on (*Brit. Med. Journ.*, 1874, vol. i. p. 403), Sir William stated that his favourite time was from "three weeks to three months."

While the rule of British surgery is to get the operation over before dentition, many German surgeons defer taking any steps till the child has entered on the second year. Thus, Prof. Billroth* announced his practice as follows:—"Unless the parents urgently demand an operation as early as possible, I generally prefer to operate on children when they are more than one year old. I always advise this in strong children with complicated hare-lips, especially when the inter-maxillary bones are displaced and the hare-lip is double. I have been particularly satisfied with the results of operation, as far as appearance is concerned, on children at rather later periods of life and in adults." Some further remarks of Prof. Billroth are quoted at p. 342.

My reasons for deferring the operation, as a rule, till after the third month, are:

* *Clin. Surg.*, Syd. Soc. transl., p. 78.

1. The difficulties of getting children with hare-lip to take sufficient food are exaggerated. Very often, unless the palate is cleft in addition, these children can suck well, and are in good condition. When the palate is also cleft, a serious difficulty may arise from the food passing into the nose, but this may be usually met by careful feeding with a small spoon put well back, if a sucking-bottle with a large teat and a good-sized hole in it fails (p. 347). This it will very rarely do, if slowly raised so as to give a little milk each time. Sometimes it is best to have the child raised when fed. The mother's milk should always be drawn and given when possible.

Where the child really cannot get sufficient nourishment, and is marasmic from this cause only, the surgeon may of course operate before three, or even two, months. But a child that is daily wasting is, daily, less and less able to meet the strain entailed by the operation, and consequent repair. This should be clearly understood by the friends, and also the following fact:

2. It is not uncommon for children with hare-lip to die soon after birth from causes quite apart from this deformity—viz., diarrhoea, lung-trouble, exhaustion. In other words, many children with hare-lip suffer also from atrophy and wasting. In such, operation is unadvisable. It will not mend matters, and death will be put down to it, and not to the above causes, which would have destroyed the child in any case. In another, smaller, class of cases the operation itself, chiefly from the pain it causes in a weakly child, seems to start a process of fatal wasting.

3. As stated by Mr. T. Smith,* “the operation can be done much more perfectly and artistically on a young child than on a new-born infant, the parts being larger, more fleshy, and more easily handled.” Sutures also cut out less readily.

4. For the first few weeks of life the child has scarcely got over the change from intra-uterine to extra-uterine life, the digestion is not yet, so to speak, in full swing, and a very slight shock may be too much for the low vitality of this period.

Condition of the Hare-lip.—Before operation, the following must be inquired into. Is the cleft single or double? If single, is it simple—i.e., without involving the nose, and without fissure of the palate? Are the sides equal and acute-angled, or divergent and unequal? Other sources of difficulty are, much flattening of the nose from the septum being adherent and dragged over to the superior maxilla on one side, and the ala of the opposite side being spread out and stretched over the upper part of the fissure. Or the edges of the lip are widely apart, and by no means to be approximated, the alæ being so widely separated that lines let fall vertically through them only just come within the angles of the mouth.

* *Lancet*, 1867, vol. ii. p. 761.

Other more general points will of course be remembered as influencing the result of the operation. Amongst these are, the digestive and sleeping power of the infant; its family history; the existence of any weakening condition, such as otorrhœa; and, by no means least, the good sense and patience of the nurse.

The **Single Hare-lip** operation and the one applicable to the largest number of cases will be first described fully, and then one or two modifications.

(i.) **The Usual Operation** (Fig. 97).—The child being wrapped in a long towel, mummy-wise, to ensure the hands being secured if it "come to" prematurely, ether or A.C.E. is given, and the head is held suitably presented to the operator by an assistant, whose hands, at the same time, make pressure upon the facial arteries as they cross the jaw. The lips, and, if needful, the alæ also, are now freely separated from the subjacent bones to allow of their coming together without tension; during this step the knife should be kept very close to the bone, otherwise the hæmorrhage will be free. Unless this step is thoroughly carried out, the tension on the sutures a little later will be certain to interfere with successful union. To render the separation efficient the knife must sometimes be carried quite up to the infra-orbital foramina, while the alæ nasi must also be thoroughly separated so that any flattening and distortion of the nostril may be rendered shapely.

If one maxillary bone project inconveniently beyond its fellow, it must now be forcibly bent back with non-serrated forceps covered with thin drainage-tube or wash-leather. The bone should be felt to crack when this is done; otherwise, if merely bent back, it springs forward again and causes tension on the flaps.

If necessary, the anterior plate of the bone must be divided with strong scissors or a very fine saw. Whichever is used, care should be taken to apply it above the level of the tooth-sacs.

Dr. Rawdon (*Brit. Med. Journ.*, 1883, vol. ii. p. 724) advises that this bone should never be interfered with if the two halves of the lip can be brought together over the projection without tension, as (1) the curing of the hare-lip is sufficient to diminish the gap and depress the projection, and as (2) by interfering with it a low condition of septicæmia may be set up.

The edges of the cleft are now pared. This, the most important part of the whole operation, must be done carefully and thoroughly as well. The surgeon seizes the lower angle of each flap, alternately, either with his left forefinger and thumb, or, if the parts are very small and slippery, with tenaculum-forceps which should not hold the soft parts too near the edge, or it will tear out too soon. The edges being thus made tense, the surgeon with a narrow-bladed, small knife pares them as widely as possible by two incisions beginning above at the upper angle of the cleft, curving outwards somewhat as they descend, quite clear of the

edges of the fissure, and then, in the lower part, curving inwards again through the red prolabium. Beginners nearly always make the mistake (Fig. 97) of removing only a thin paring of red surface. The pared surfaces should be made as wide as possible, especially below, in order that the sutures may hold better and the lip be deeper. If one margin of the flap is longer than the other this should be pared first, and after this its fellow, that both may correspond. During this paring, hæmorrhage must be prevented either by the assistant who compresses the facial while he

FIG. 97.



(After Whitson, *Edin. Med. Journ.*, 1883, p. 7.)

The dotted line shows the cleft widely and freely pared. The dark one shows timid paring close to the prolabium. The advantages of the first incision are—(1) A broader lip. (2) Firmer union, as a greater number of vascular points are cut which will throw loops across. (3) A better grasp for the sutures. (4) A more vertical depth to the lip, the two points, A, A, being on a lower level than B, B. The lower ends of the dotted lines should have been shown curved downwards and inwards in the usual way.

supports the head, or by an assistant compressing the coronary artery, between his finger and thumb, at the corner of the mouth, or by hare-lip clamps placed at the corners of the mouth.

The assistant who steadies the head and keeps pressure on the facial arteries, now, with two fingers, presses the cheeks together, so as to bring the flaps into apposition while the surgeon introduces his sutures. I much prefer for these, first, one of stout well-soaked salmon-gut to command the coronary arteries, and passed close to the mucous membrane. If one flap is still shorter than the other, this stitch may be passed through the opposite side from below upwards, then entered on the shorter side at a point a little higher than that at which is left its fellow and passed from above downwards so as to tilt down the margin which is highest and bring it level with the other. This first stitch being passed, and the chief fear of bleeding removed, three or four others of finer gut, horsehair, or fine carbolised silk are inserted. one being placed in the free margin of the lip to keep the wound carefully closed here against the entrance of milk, saliva, &c. In adjusting the top stitch care must be taken that it does not too much depress the tip of the nose, if the cleft has been one

running up into the nostril. All the chief stitches should be inserted with very fine needles, $\frac{1}{8}$ inch from either side of the cleft.

It will be gathered from the above that I do not advise the use of hare-lip pins. They are useful no doubt in promoting close and accurate union where the parts come together easily, but at the expense of the risk of sloughing and scars even here; where tension is considerable this risk is very much increased. The surgeon will, I think, do more wisely who adopts the sutures already described, preventing tension by freely separating the soft parts from the bone. If pins are used they should be far slenderer than those usually sold, the first should be inserted low

FIG. 98.



Single hare-lip, with wide cleft, the two sides widely divergent and not on the same level.

down so as to command the coronary arteries, and if one side of the cleft is shorter than its fellow the pin should be passed, so as to draw it down, in the manner already described. They must be removed at the end of forty-eight hours or scar-points will be left. And in feeble children the above time is too short for firm union to have taken place.

The sutures being tied, the nostrils are cleared of any clots, some iodoform, or Jeyes' powder, is dusted over the wound, collodion* is painted on evenly, and the following dressing applied:

A piece of iodoform or sal alembroth gauze two layers thick should be cut before of appropriate size and of butterfly shape, so that one wing can be fixed upon each cheek, while the uniting portion, just the width of the lip, passes over the wound. This dressing is

* The collodion will not only help to hold the parts together, but will prevent milk, saliva, &c., from getting between the flaps.

secured in place with collodion, and while it is being adjusted, an assistant holds the cheeks forwards, a position which must be maintained until the collodion is firm. For this most useful dressing which keep the parts together and protects them from saliva, &c., I am indebted to Mr. Rose (*Hare-lip and Cleft Palate*, p. 84). It is as efficient as it is simple.

In the after-treatment, the wound may be looked at on the second or third day, the stoutest salmon-gut or silver wire removed on the fourth day, and the others left in much longer. A camel's-hair brush is the best way of cleansing the wound. On each occasion the cheeks must be most carefully supported, while a similar dressing to that described above is applied.

FIG. 99.



The same case, three weeks after operation. The lip is broad and deep, and the red line level. The septum is still a little dragged down. The patient was a healthy country infant with a devoted mother, sent me by Dr. Roland Cox, of Kintbury, Hungerford.

One point of great importance is not alluded to in surgical works, and that is, that in some cases of hare-lip death from dyspnoea may take place very soon after the operation. Thus, where the cleft has been a large one, and the upper lip when restored is tight, when it overhangs the lower, if the nostrils are flattened and partially closed by the operation, owing to the tension of the parts, so little breathing space may be left that temporary interference with respiration may occur with grave and even fatal results before the breathing can be accommodated to the altered circumstances, and before the parts dilate and stretch.

The first case that drew my attention to this accident occurred in the early part of 1887 at Guy's Hospital. I had operated on an infant, aged three months, with a large cleft with unequal sides, and going through the alveolar margin, the two halves of these being on different levels. The projecting alveolus was broken back into position, pared, and stitched with chromic catgut to its fellow. The edges of the cleft were then pared and united. They came together excellently,

the wide cleft being replaced by a deep upper lip. One nostril was rather chink-like. About half an hour after, whilst I was engaged in another operation, a message came that the child was livid and dying. I had the child at once brought to me in the theatre, the strapping was removed, the tongue carefully drawn forward, and artificial respiration performed. The child quickly came to and began to cry, though not very vigorously. Three-quarters of an hour later its breathing again failed, and, though Mr. Wachter, the senior house-surgeon, at once repeated the artificial respiration he was unable to resuscitate the child. At the post-mortem examination no clot was found in the fauces, nor anything else wrong.

I find that my old friend G. A. Wright,* of Manchester, has recorded two such cases:

The children here were aged three and five weeks respectively, the hare-lips double; in one, after the operation, the lower lip was drawn in so much as to leave but a small opening, but there was not apparently any dyspnœa. In one case dyspnœa came on suddenly, and, as no relief followed on pulling the tongue out, tracheotomy and artificial respiration were performed. The child came round, but a few hours later the breathing failed again, and the child died. In the second case, the child was found dead in the night. "The cause of death was probably valve-action of the lower lip."

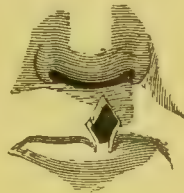
Mr. Rose (*loc. supra cit.*, p. 85), draws attention to the need of the nurse depressing the lower lip frequently with the index finger, or by painting on a strip of collodion between the lip and the chin, until the child has become accustomed to the diminished oral

FIG. 100.



(Nélaton.)

FIG. 101.



(Nélaton.)

aperture, otherwise the efforts to draw air through the closed mouth will tend to disturb the wounded surfaces.

In a few cases of hare-lip where the divergence is great, and where the sides of the cleft are very unequal, the following operations may be made use of, but it will be found that, on the whole, the first-mentioned is not only the quickest performed, but also gives the best results in the largest number of cases, as long as the flaps have been freely separated from the jaws and the edges broadly pared.

(ii.) Operation of Clémot † or Malgaigne (Figs. 100, 101).—The

* *Abstracts of Cases Treated at the Pendlebury Hospital*, 1885, p. 146. In his Abstracts for 1883 Mr. Wright records a case in which, after operation for hare-lip, there was so much dyspnœa, from the tongue clinging to the roof of the mouth at each inspiration, "that it had to be pulled out and fastened by a ligature."

† M. Nélaton (*Pathol. Chirurg.*, t. iv. p. 496) states that M. Malgaigne here imitated M. Clémot of Rochfort.

edges are pared down to, but not beyond, the red lines, the flaps thus detached above are turned downwards and kept out of the cleft with a probe. The upper part of the cleft is then sewn together with the sutures already advised, while the projecting point is shortened as required with a pair of sharp scissors and united with one or two points of horsehair. The chief objection to this method is, that, unless great care is taken, a little skin, imperceptible at first, but showing white after a time, may remain below the red line, or as a break in it. Again, the projection is very liable to get in the way during feeding.

Where the divergence is more marked, and the sides of the cleft very unequal, the following may be made use of.

(iii.) **Method of Mirault** (Figs. 102, 103).—On the side which is

FIG. 102.*



(Nélaton.)

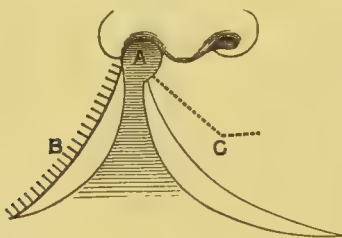
FIG. 103.



(Nélaton.)

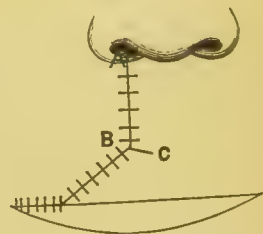
the most vertical of the two an incision is to be made downwards and outwards from the apex of the cleft to the junction of skin and mucous membrane, so as to leave a flap on this side free above, but attached below. The other more sloping side is then freely pared throughout its extent from the apex downwards and outwards. Any adhesions of the lips to the gums being then

FIG. 104.



(Owen.)

FIG. 105.



(Owen.)

thoroughly separated, the flap is brought across and attached to the pared opposite side with the sutures already mentioned.

If this method be made use of, the flap must not be a mere paring, but cut as thick and succulent as possible, and the opposite side must be thoroughly and widely refreshed.

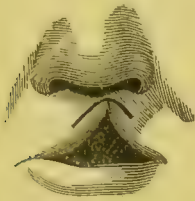
Figs. 104 and 105 show a modification of the above introduced by Mr. Owen (*Lancet*, 1887, vol. ii. p. 361). The right lip is first

* The sides, especially the one which is refreshed throughout its whole extent, should be pared as in Fig. 103—that is, somewhat angularly—as as to promote the adjustment of the flaps, as it were by interlocking.

widely pared. To free the flap which is to be brought across from the left side, the incision is first made as usual from A to C, and then outwards. The object of this outward prolongation is to enable the flap to lie level smoothly when it is brought over—*i.e.*, without kinking, to which there is otherwise a tendency.

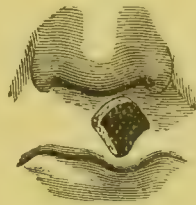
(iv.) **Method of Nélaton** (Figs. 106, 107).—This gives another means of substituting a protuberance for the cleft. An incision resembling a V reversed is made around the upper angle of the cleft. By this means the red edge of the cleft is separated from the two halves of the lip, except at each corner below. This red edge is next turned downwards, or reversed so that the Λ -shaped

FIG. 106.



(Nélaton.)

FIG. 107.



(Nélaton.)

wound becomes diamond-shaped. The bleeding surfaces are then brought together by the means already given.

Mr. Holmes (*loc. infra cit.*) considers that Nélaton's operation is peculiarly adapted to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril. These instances are rare, but Mr. Holmes further points out that in cases where an unsightly notch is left behind, if there be not much cicatrization around the incision, the deformity may be almost certainly remedied by this operation.

DOUBLE HARE-LIP (Figs. 108, 109).

This is often easier of cure than single hare-lip with very divergent sides and the alveolar margin cleft and its two parts on unequal levels. For in double hare-lip the mischief is often symmetrical, and the sides less divergent.

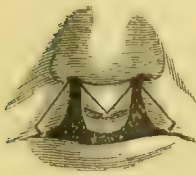
Mr. T. Smith (*loc. supra cit.*, p. 799) gives the three following varieties of hare-lip which are met with here and which are of practical importance:

- (a) When the pre-maxillary bone is *in situ*, and the two clefts are simple and fairly bilateral.
- (β) When the pre-maxillary bone is separated from the rest of the jaw and projects forwards, in some cases slightly, in others being attached to the vomer and hanging from the tip of the nose.
- (γ) When the pre-maxillary bone is small and ill-developed, and when the clefts are widely gaping.

The first two of these require notice.

(a) If the pre-maxillary bone is in proper position, the skin over it is freed from its attachments behind and pared to a point. The sides of the cleft are next pared from above downwards (as in Fig. 108), and the parts brought together by transfixing the sides and the central flap with a silver wire suture, every care being taken to keep the central piece well down. Horsehair and salmon-gut sutures are also used as well. As the central piece is always shorter than the lip itself, the resulting wound is Y-shaped, and it is the side flaps which meet each other in the middle line below. Care must be taken to free the central flap right up to the nose, and not to depress it too much with the sutures, otherwise the nose will be flattened.

FIG. 108.



(Nélaton.)

(β) Cases in which the pre-maxillary bone is separated from the maxillæ, projecting forwards, sometimes being even attached to the very tip of the nose.

The question of removing or leaving the pre-maxillary bone arises here, and the very best authorities have differed widely. Many have advised its removal, if it projected much, because (1) pressing it back is difficult and unsatisfactory; (2) if it be pressed back, it rarely unites by bone; (3) in such a case it will act as a wedge, preventing closure of the alveolar arch and palate-fissure; (4) the teeth in it (the central incisors) cannot be relied upon to come through usefully; and (5) a dentist can fit a plate that will answer the purpose quite as well. On the other side, Mr. Holmes* argues thus: "It is of the highest importance to preserve, if possible, this portion of bone, for these reasons: (1) If the bone be removed, there must be a permanent gap through the hard palate. (2) There must also be a flattening and malposition of the upper lip, in consequence of its having lost its bony support; and from this flattening of the upper jaw it will result that the lip will be very short and tense, and the patient extremely 'under-hung,' a very unpleasant deformity."

FIG. 109.



(Holmes.)

(Fig. 109). To this I would add two more—that (3) the presence of this bone is needful for the preservation of the due width and arch of the bone, and (4) that such an arch will best carry artificial teeth, if any are needed owing to the unsatisfactory eruption of the natural ones. Thus most surgeons will prefer to follow Mr. Holmes' advice. Mr. Holmes, a little later, goes on to say that in a few cases it may be necessary to sacrifice the bone—

* *Surg. Dis. of Children*, p. 108.

e.g., where it is very far forward, very much out of proportion to the neighbouring parts, and the child very weak.

I am of opinion that, if the following points be attended to, the pre-maxillary bone, however advanced and firmly based, can be replaced and preserved; weakness on the part of the child, which is undoubtedly a matter of grave consideration in cases like this where the loss of blood is considerable, is best met by doing the operation in two stages—in other words, being content to first get this bone replaced, and leaving the uniting of the soft parts till another time.

Where the stalk of attachment of the pre-maxillary bone is slender, and where there is plenty of room between the two maxillæ, it may be often broken back into place by the operator supporting with his left hand the back of the child's head and then with his right thumb sharply fracturing back the bone. This should be done thoroughly, and, if needful, by the aid of non-serrated forceps covered with drainage-tube, or bone-forceps may be applied to the stalk in front and also behind till it is almost completely cut through. If now it can be replaced, but tends to come forward again, it should be sutured, on one side at least, to the maxillæ with chromic catgut or carbolised silk, or wire.

If the maxillary bones on one side or both are in the way, and prevent the replacing of the pre-maxillary bone after it has been detached sufficiently, or, if this is too voluminous, its sides must be cut away and the maxillæ also pared till the central piece can be pushed back between them and retained with a suture, as above advised.

A severer method, one, therefore, which should only be tried when all other means of replacing the pre-maxillary bone have failed, is to cut a wedge-shaped gap out of the septum nasi and to press or fracture the partially detached bone into the gap. Some have passed a suture* through the septum before the wedge is cut out, and then united the ends over the pre-maxillary bone to keep it in place.

The hæmorrhage may be very free in these cases where very vascular bones are cut through. I have generally found that it is at once arrested by suturing the bones, but in some cases it may be needful to apply a fine point of actual cautery or of the thermo-cautère: if this has been necessary, or if the child is very weakly, the uniting of the soft parts had better be left to another time.

It is absolutely necessary, by some means or other, to get the pre-maxillary bone quite back and to make it stay there, as otherwise the soft parts over the projecting bone, or the line of union which often comes just opposite to it, will be pressed upon and give way.

* If he do this the surgeon must be provided with needles of different curves. Small curved ones in a holder offer more variety than those in handles.

So where the surgeon is unable to get the bone back by any method, he may follow the advice of Sir W. Fergusson,* and incising the mucous membrane over the bone, separate this sufficiently to introduce a small gouge about $\frac{1}{4}$ inch broad, scoop out the temporary incisors, and cut away the wall of bone, which for the first eight weeks consists of merely a few plates. By this the projection is removed, and the tissues which remain offer no obstruction to the union of the lip in front. Only the mucous membrane and some periosteum are left to form a soft cushion behind the united lip.† Furthermore, by this means the loss of blood is diminished.

Causes of Failure and Death after Hare-lip Operations.—Amongst the commonest of these are—(1) Feeble vitality. Marasmus. Many infants die after hare-lip operations, but while the effect of loss of blood and pain must not be lost sight of, in most of the fatal cases death is due, not to the operation, but to feeble vitality. Whether operated on or not, the majority of these cases would have died in infancy. (2) Hæmorrhage. This, if serious, is due either to very free separation of the flaps in a weakly child, or (a cause much less excusable) to the coronary arteries not having been properly secured. Loss of blood will lead to non-union, but it may destroy life rapidly by a clot in the fauces and upper aperture of the larynx. One case has come to my knowledge in which, after operation, this untoward result would have happened, the child getting increasingly blue and breathless, had it not been for the prompt common-sense of the nurse in charge, who fished out a large clot with a sponge on a holder. (3) Bronchitis and broncho-pneumonia. (4) Diarrhœa. (5) Asphyxia (p. 336). (6) A low septic condition, especially where the bone has been interfered with in a weakly infant, and under conditions always adverse to aseptic healing.

Repetition of Operation.—I may remind my younger readers that in many cases a perfect result cannot be secured by one operation. Where parents are likely to be unreasoning and unreasonable, the surgeon should warn them of this.

In cases unfavourable, owing to the malformation, or the general condition (p. 332), hare-lips which have been operated on often cause disappointment, however much they resemble pictures in books up to the third day. Incomplete closure, below or above, a little inequality in the levels of the halves of the new lip, some flattening and closure of the nostrils—any of these may mar the first operation. The more operations a surgeon does the more difficult and trying cases will he meet with. He can scarcely do better than remember the words of the great surgeon of Vienna (Billroth, *Clin. Surg.*, p. 79): “Operations on little children do not always succeed as well as could be wished, on account of the

* *Brit. Med. Journ.*, loc. supra cit.

† This cushion can be stitched to the maxillæ, if needful.

diminutive size and softness of the parts. The flaps of the lips cannot always be adapted as exactly as desired, and even if this be satisfactorily accomplished, the result does not in every case quite come up to expectation, so that, some few years after, further slight proceedings become desirable, in order to improve the appearance." And, again, a little later, the same surgeon, speaking of operations on "quite little children," says: "I decline to give any absolute guarantee with regard to the result in such cases."

OTHER PLASTIC OPERATIONS ON THE LIPS

(Figs. 110 to 113).

These are very numerous, especially for the restoration of the lower lip after ulcerations, epitheliomatous, &c., injuries and burns. A few of the chief will be described here.

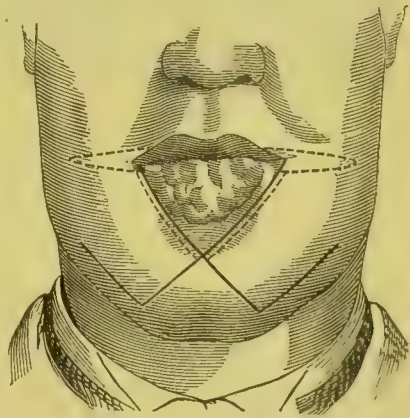
The chief objects which the surgeon must keep before him are: (1) to get sufficient flaps of healthy tissue, consisting of skin outside and mucous membrane within, and to secure as free a margin as possible of this last; (2) to keep the flaps together with as little tension as possible; (3) to cover in the teeth sufficiently, preserving the mouth-opening of appropriate size.

Lower Lip.

(i.) **Method of Serre** (Fig. 110).—Where a growth implicates the whole of the lower lip, but does not extend far down upon the chin, this operation gives excellent results. If the angles of the mouth are also involved, the operation consists practically in removing three triangular portions of soft parts, as shown in the dotted lines in Fig. 110. Two of these have their apices on the cheeks, and their bases at the angles of the mouth, while the central triangle has its apex downwards towards the chin, and its base turned upwards to the mouth.

If the angles are not involved, straight incisions, and not triangular ones, may be made out on to the cheeks, while, if needful, the apex of the central can be carried down on to the chin or even on to the neck, some further incisions being usually required in such a case—viz., curving outwards laterally from the apex along the jaw or in the sub-maxillary region, as in Fig. 110. The flaps are united with silver wire, salmon-gut, and horsehair; a few fine hare-lip pins being used, if needful, to overcome tension. The sutures should be put in sufficiently close to distribute any tension evenly, and the chief ones should be one-

FIG. 11C.



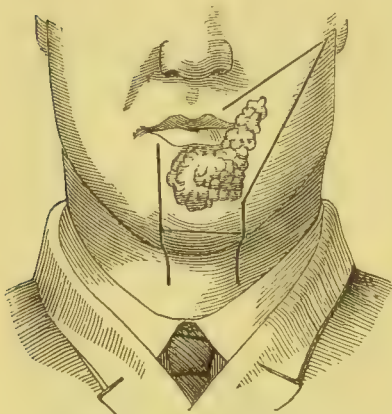
The dotted lines show the operation of Serre, the continuous ones that of Syme. The central part of each runs too near to the growth.

third of an inch from the edges of the wound, and should be passed close to the mucous membrane. As far as practicable, bleeding points should be commanded by sutures, and torsion or ligatures dispensed with as far as possible. Any pins used should be removed on the second or third day, and the sutures one or two at a time. Iodoform and collodion is as good an application as any.

(ii.) **Method of Syme** * (Fig. 110).—This operation leaves the central and prominent part of the chin undisturbed, two lateral flaps supplying the defect.

Supposing the whole lower lip affected, the growth is removed by two incisions passing from the angles of the mouth to the prominence of the chin. Bleeding-points being compressed by assistants, the surgeon makes two incisions from the apex of his first, passing at first straight downwards and outwards, and then curving outwards and upwards, so as to free two large lateral flaps, which are

FIG. 111.†



The quadrangular incisions on the chin will indicate the method of Chopart. The triangular incisions show how a growth at the corner of the mouth may be dealt with. (After Serre.)

dissected up as thick as possible and united in the manner already described. The first part of the two lateral incisions—viz., those passing downwards and outwards—meets in the middle line to form the new lip. This is supported by the prominence of the chin, which retains its natural connections. The lower and more curved parts of the incision must be carried outwards towards the angles of the jaw in order to allow the flaps to come into position readily, and without tension, and without leaving gaps to granulate.

(iii.) **Method of Buchanan**.—This is planned on the same lines as that of Prof. Syme. The growth is removed, here, by an elliptical incision. From the centre of this two incisions are made, first downwards and a little outwards, and then from the ends of these two curving outwards and upwards, much as in Prof. Syme's operation. When flaps thus marked out are detached and raised, the elliptical incision becomes horizontal and forms the new lower lip.

Both in this and Prof. Syme's operation, when the gap is very large or the soft parts scanty, two small triangular gaps may be left below. These will heal by granulation, promoted by skin-grafting.

* *Observ. in Clin. Surg.*, p. 60.

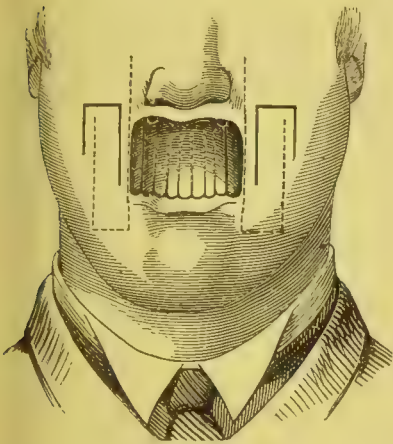
† This and the next two figures are taken from M. Serre's atlas accompanying his *Traité sur l'Art de restaurer les Difformités de la Face, selon la Méthode par Déplacement*. Montpellier : 1842.

(iv.) **Method of Chopart** (Fig. 111).—The growth is removed by a quadrangular incision, the upper margin being formed by the lip, the lower by an incision parallel with it across the chin, and at the sides by two vertical lines dropping down over and below the jaw. A square-shaped flap is then dissected up from below, and brought up to form the lower lip. The weak point is that, in spite of keeping the head flexed, the flap tends to sink down. This might be, in part, prevented by freeing the flap more completely by carrying out into the sub-maxillary regions lateral incisions curving outwards and upwards from the ends of the vertical ones.

Upper Lip.

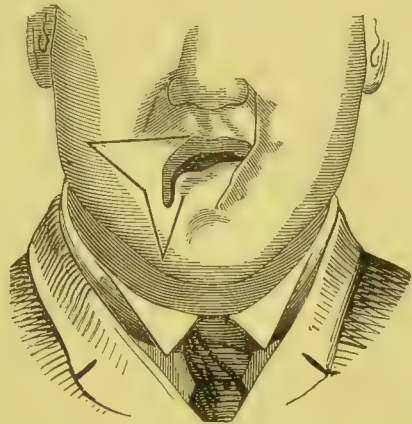
(i.) **Operation of Sédillot by Vertical Flaps** (Fig. 112).—Flaps quadrangular in shape are raised by the following incisions: (1) the internal one, starting from a point midway between the

FIG. 112.



The dotted lines show the operation of Sédillot, the continuous ones that of Dieffenbach, for making a new upper lip. (After Serre.)

FIG. 113.



(After Serre.)

angle of the mouth and the lower eyelid, and ending usually at a point on a level with the prominence of the chin; (2) a horizontal one passing outwards from the lower end of the first for $\frac{1}{2}$ to 2 inches; and (3) a second vertical incision passing upwards from the outer end of the horizontal one to a point on a level with the ala of the nose.

These flaps, comprising the whole thickness of the cheeks, are moved inwards so that their lower extremities meet vertically in the middle line.

(ii.) **Operation of Dieffenbach and Chauvel by Vertical Flaps**.—Here the flaps are cut in the reverse direction to that of Sédillot. This method is to be preferred, as, owing to the base being below, there is less tendency for the new lip to be raised by the contraction of the scar, and thus to expose the upper teeth.

(iii.) **Operation by Lateral Flaps**.—Here the flaps are taken

laterally from the cheeks. They should be cut of the full depth of the new lip, and at their outer extremities should curve downwards so as to diminish the tension.* Their inner extremities are united in the middle line below the nose.

(iv.) **Operation for Restoring One Angle of the Mouth.**—Fig. 113 shows the steps which would be adapted for restoring the right angle of the mouth which has been distorted by cicatricial contraction: the same proceeding being available for a growth situated here.

* Dr. Port, of New York, who figures this operation and numerous other methods from Szymanowski (*Handb. d. Chir. Med.*, Braunschweig, 1870), lays stress upon this precaution (*Inter. Encyc. Surg.*, vol. v. p. 489).

CHAPTER IX.

OPERATIONS ON THE PALATE.

OPERATIONS FOR CLEFT PALATE—REMOVAL OF GROWTHS OF THE PALATE.

OPERATIONS FOR CLEFT PALATE (Figs. 114 to 123).

Age for Operation.—If the general health be good,* the temper fairly sweet, and the cleft not a very wide one, the first attempt to close the gap may be made any time after three-and-a-half or four years. If any further operation is required it should be performed in the fifth or sixth year, and any case, however difficult should be completed, if possible, by the ninth or tenth year. As a rule, the healthier the child and the smaller the cleft, the earlier may the operation be tried.

Operations have no doubt been performed during the first year of life, but the risk of failure is great owing to the effects of hæmorrhage, the readiness with which convulsions are excited, the delicacy and promptness to tear of the soft parts, while, as has been pointed out by Mr. T. Smith, during the first three or four years, clefts of the bony palate generally diminish much in width.

Severity of the Case and Kind of Patient.—It is not so much the extent of the fissure—whether the soft palate is alone affected, partially or completely, whether that common form, in which the cleft involves the soft and a portion of the hard is present, or whether the whole part is split—that is of importance, as the width of the cleft and the thickness of the tissues which bound

* The difficulty of feeding these cases is often put forward by the friends as a reason for an early operation. Cases are extremely rare in which sufficient food cannot be given by one of the following methods (especially after any co-existing hare-lip has been closed), if only sufficient pains are persevered with—viz., a small spoon passed well back into the mouth; a feeding-bottle with a teat big enough to fill the gap, the teat being perforated underneath for the escape of the milk, only a little being given at a time; an ordinary feeding-bottle, with a leaf-like piece of india-rubber attached above the teat, so as to fill up the gap (as advised by Mr. Coles); finally, sometimes deglutition will be facilitated if the nurse closes the nostrils with her finger and thumb every time the child swallows, or feeds the child well propped up.

it. Sir W. Fergusson was, I believe, the first who pointed out the influence which the height of the vault of the hard palate has upon an operation for closing a cleft of it. He showed that the higher the vault the more easy was it to dissect down flaps of muco-periosteum, while, on the other hand, the less arched the vault, the greater was the difficulty in getting sufficient flap. Other points of importance are the size of the mouth, a very narrow or small one interfering with the use of the needful instruments; and finally, a point always to be noted, the length of the palate, for

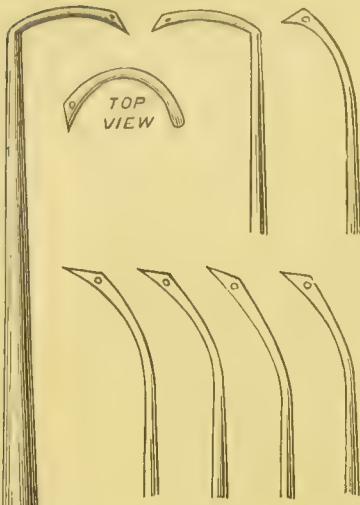
the shorter this is, the more impossible will it be for this to touch the pharynx later on, however perfectly it has been united, and the more marked, consequently, will be the nasal tone of the voice.

Other points of importance, but not connected especially with the cleft are, some which bear upon the general health of the patient—viz., fretfulness or a sunny temper, greediness, as likely to cause bolting of surreptitious food, co-existing ear disease, or congenital syphilis; whether the child has had the usual illnesses and exanthemata; an attack of whooping cough, scarlet fever, mumps, or measles, interfering much with the result of an operation.

Amount to be closed

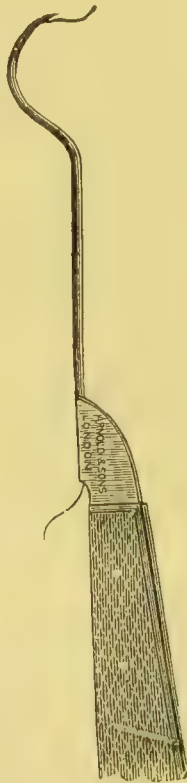
at one Sitting, and Order of Operation.—Where the cleft involves both palates, that through the soft is usually taken first, the

FIG. 114.



Durham's needles of different patterns.

FIG. 115.



Cleft palate needle, tubular.

FIG. 116.



Cleft palate needle, Durham's double curve.

severer operation being left till later. As to the amount which should be attempted at the first sitting, each case must be decided by itself, according to the experience of the operator, the severity of the case, and the safety with which the anæsthetic is taken. Mr. T. Smith, the highest authority we have on this subject, recommends * that the whole cleft should be closed at one sitting, "unless there are circumstances of peculiar difficulty in the case. When the bringing together of the whole cleft in one operation would necessitate so free a division of the soft parts as to endanger the vitality of the flaps, it is advisable to close first that part of the cleft that can be most easily approximated, whether it be the hard or the soft palate."

Had it not been for this opinion of Mr. Smith's, I should have unhesitatingly advised the surgeon, in his earlier operations, only to attempt to close those parts which come readily together. Any more that can be closed will only be so at the expense of a good deal of tension, and after much difficulty and a varying degree of bruising, &c.

Operation on the Soft Palate.—The instruments which would be required for closing a complete cleft of the palate may be enumerated here once for all. One double-edged and one blunt-pointed knife (like a large tenotomy knife on a long handle), one pair of dissecting-forceps, and one with fine tenaculum or mouse-tooth ends, several needles of different patterns with eyes at the point, or a supply of small needles of different curves, to be used with a holder, a stout aneurism needle, four raspatories of varying curve and strength, a pair of curved scissors (with a $\frac{1}{4}$ inch curve) for detaching the soft palate from the hard, one of Mr. Smith's gags, which has previously been found to fit the patient, and sponge-holders. In addition to the above, a tubular needle with a reel for passing wire, and a wire twister will be found useful.

The patient's stomach being just empty, so that he shall not vomit during the operation, nor want food immediately after, he is placed on a suitable narrow table, and in a good light. As soon as he is well under the anæsthetic (A. C. E. or chloroform), his hands and arms are secured in a jack-towel, one being always left within reach of the chloroformist. Then either the head and shoulders are suitably propped up with firm pillows, or, as I much prefer, the head is dropped at a right angle to the spine, over the end of the table, where it is supported by a sitting assistant. This method, which I believe we owe to Prof. Annandale,† has the great advantages of giving thorough exposure of the parts now well under the surgeon's control, and of allowing the blood to collect in the upper naso-pharynx. Mr. Smith's gag is then introduced, the tongue tucked under the central plate, and the jaws widely opened. The gag, which it is well not to tie, is then held by an assistant who, at the same time, supports the head, and moves it to

* *Dict. of Surg.*: art. "Cleft Palate."

† *Lancet*, 1879, vol. ii. p. 685.

suit the operator. Another assistant hands instruments and gives other help, while sponges are wrung out and supplied on holders by a nurse.

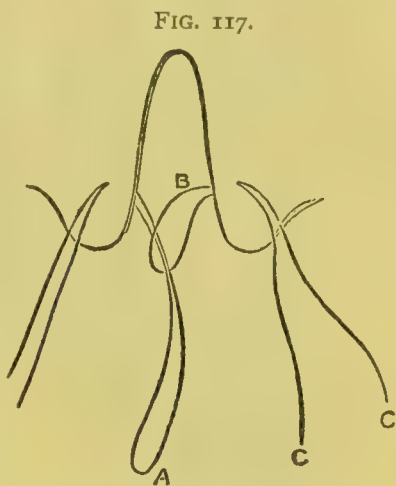
The edges of the cleft are first pared in one of two ways—viz., by holding in the tenaculum-forceps the tip of one-half of the uvula, and thus making the soft palate tense, and then transfixing the centre of each cleft alternately with a double-edged tenotome, and cutting first up and then down. In either case the whole of each side should be made raw, and with as wide a surface as possible; it is the anterior angle and the tip of the uvula which are liable to remain unrefreshed. As far as possible this should be the only occasion on which the flaps are touched with the forceps.

The sutures may be made of wire (without kinks), carbolised silk, salmon-gut, and horsehair. Of these Mr. Smith prefers wire for the hard palate and for any part of the soft in front of the uvula, preferring horsehair for the uvula itself.

If the flaps are thick and abundant, if they fall easily together, the material is, I think, of less importance. Each surgeon will, in difficult cases, find advantage from being used to certain sutures. If the surgeon has tubular needles, and if both sides of the cleft can be spanned at once, he will find it very easy to work with silver wire. Salmon-gut and horsehair seem to me to be the least irritating next to wire, and very easy to work with after being softened for ten minutes in a hot solution of carbolic acid. But if the cleft is a wide one, and if Aveling's method is preferred, it is difficult to obtain the last two forms of suture in sufficient length, and carbolised silk should be made use of.

The following methods will be found useful according to the width of the cleft, and the needles used: (1) If a tubular needle is at hand, silver wire can be passed with great facility, if the cleft be a narrow one, save in the case of the uvula, for which horsehair should be used. If the cleft be a wide one, the sutures may be passed in one of the following ways: (2) A slightly curved needle in a handle is passed through the edge on one side into the cleft, it is then threaded with wire and withdrawn, the wire is disengaged, the needle passed similarly through the other side and threaded with the end already passed; this is then drawn through the second side by removing the needle, the wire being thus brought across the gap. I owe my knowledge of this, Mr. Hardie's very simple method, to an old friend, G. A. Wright. (3) Aveling's: a double loop of suture—this is much more easily done with silk—is passed on one side and the loop drawn out of the mouth and held by an assistant; a single suture is then passed through the other side at a point opposite to this, and the end also drawn out of the mouth: this single suture is then looped into the double one, and by pulling this latter back the single one is drawn across the cleft. (4) Fergusson's method. This is another admirable method, and is especially adapted where it is intended that the silk passed should be carriers of silver wire, which is to be the permanent

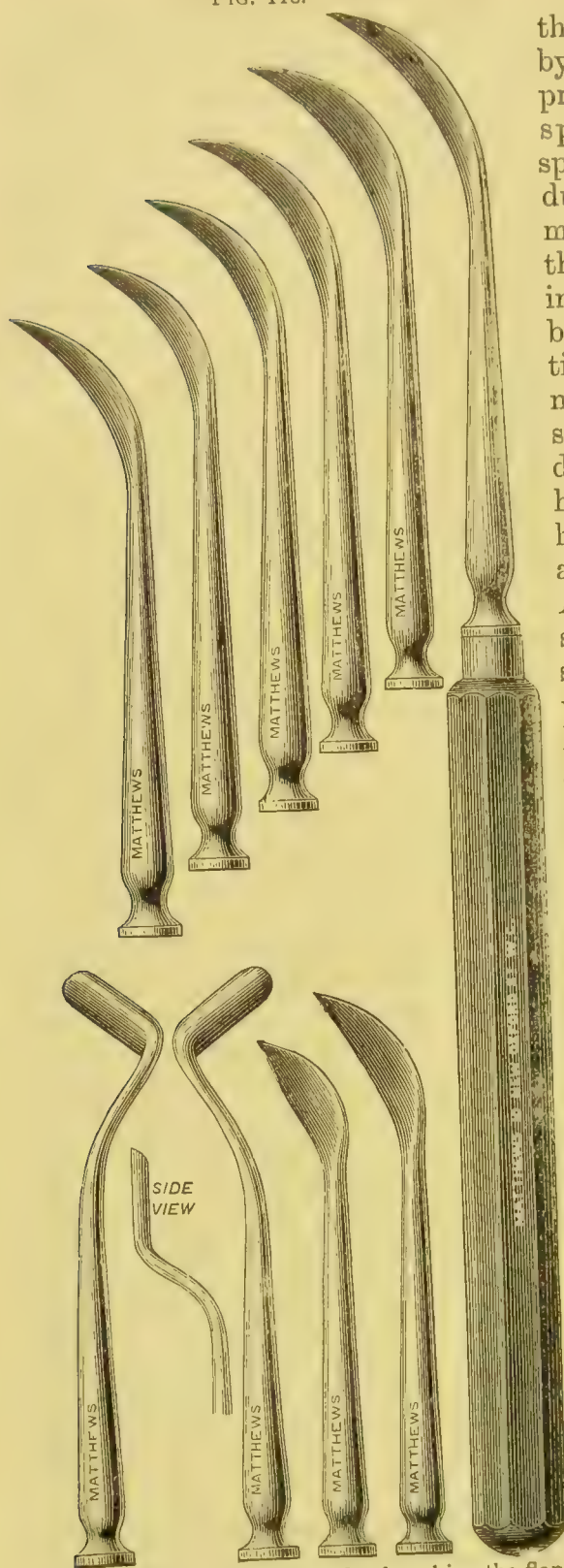
suture. One of the needles shown in Fig. 114, threaded with medium-sized sterilised silk about 16 inches long is passed through the oral aspect of the flap, sufficiently far from its margin to give good holding, and to allow for paring, if this has not been done already. The loop of silk (A) is next seized by forceps, introduced within the cleft, the needle withdrawn, and the loop pulled forward sufficiently to be laid temporarily on the face, where the anaesthetist or an assistant takes charge of it. The same thing is then done at an exactly corresponding point on the opposite side. By loosely threading the one to his left through the one to his right (B, C, C), and gently pulling on the latter, the surgeon safely carries the former through the flap that lies to his right side (Fig. 117). He then takes a piece of silver wire of suitable size, about 6 inches long, and doubling half an inch of this into a hook over the loop, by gently pulling on the free ends of the loop, he draws the wire into its place across the cleft. (5) Here they are passed much as in uniting an ovariotomy wound. A small curved needle is threaded at each end of a suture, and one is first passed in a needle-holder from right to left and the other from left to right. An assistant holds one needle while the surgeon is using the other. The second and fourth methods are the easiest of all, and as efficient as any.



Loop-method of passing sutures.
(Mason.)

After the first suture is passed through the halves of the uvula, it should be used to make the edges tense, thus doing away with any need of the forceps. Attention should be paid to inserting the sutures at a sufficient distance from the edge and a due distance from each other so as to duly distribute amongst themselves any tension that may be present. In passing any suture, the needle point should be quickly stabbed through at the intended spot. When sufficient sutures have been passed, two or three should be tied (the wire being twisted with the fingers, with a twister, or torsion-forceps), the gut and horsehair requiring a third knot. Then if there is too much tension on the rest, longitudinal incisions may be made on each side of, and parallel to, the cleft. The length of these relieving incisions must vary; they usually begin on a level with the highest stitch in the soft palate, and run backwards about midway between the teeth and the cleft, care being taken not to prolong them dangerously near the posterior pterygo-palatine canal (p. 358). Where there is great tension, as in very wide clefts, these incisions must be carried boldly backwards through the soft palate, anterior pillar, and even through the substance and free margin of the tonsil. The bleeding will be severe, but yields to pressure applied firmly, and all tension is thus relieved.

FIG. 118.



Mr. Durham's raspatories for detaching the flaps in cleft palate operations. Those in the left-hand lower corner are useful in closing the anterior part of the cleft.

Throughout the operation the bleeding must be arrested by careful assistants making pressure firmly on the right spot with small aseptic sponges in holders. Pressure duly and carefully applied may be relied upon to arrest the bleeding without damaging the flaps. There must be no unnecessary manipulations of these, and above all no bruising of them. Dabbing sponges about needlessly does no good as regards the hæmorrhage, while it is harmful in exciting mucus and injuring the soft parts. Any clots that may form should be deftly caught in a sponge with a turn of the wrist, and quickly removed. If the blood, in spite of the above precautions, collect in the pharynx and nose, the child should be turned right over, the head held by the hair, and the blood allowed to run out into a basin on the floor. If much blood get into the stomach, it is a certain emetic.

The after-treatment and the causes of failure are given a little later, at pp. 356, 358.

Operation on the Hard Palate.—An incision is made on each side down to the bone with a small stout scalpel, from a point a little anterior to the apex of the cleft immediately behind the lateral incisor, parallel with the alveolar margin, back to one opposite to, and just internal to the last molar tooth, and reaching from the anterior edge of the cleft to the posterior edge

of the hard palate. Through this incision raspatories (Fig. 118) of suitable length and curve are introduced next to the bone and pushed inwards till their points appear in the cleft. By movements from without inwards the mucous membrane and periosteum are separated from the bone, every possible care being taken to raise these of even thickness and without laceration or button-holing. The chief difficulty will be met with at the two ends of the bony clefts. If the anterior extremity of the gap reaches as far as a point just behind the incisors much difficulty will be met with in separating the muco-periosteum here, and the surgeon will do well to be provided with two or three small raspatories of different curves. The double-curved ones (Fig. 118) bearing Mr. Durham's name, and of old so skilfully used by his deft fingers, are very useful. Again, at the junction of the hard and soft palates, the soft parts are firmly bound down to the former by fibrous tissue. To free them the raspatory should be thoroughly pushed into the cleft at the junction of the oral and nasal mucous membrane. A pair of angular scissors may also be used, one blade being placed under the muco-periosteum, between it and the bone, and the other passed through the cleft, above the soft palate, the fibrous tissue being thus divided close to the bony palate. A third spot where difficulty is always experienced, and where much attention is needed, is the attachment of the soft parts in the neighbourhood of the hamular process. Here a curved raspatory, a blunt-pointed narrow curved bistoury, or curved scissors—each being kept close to the bone—must be thoroughly used. As Mr. Rose advises, the introduction of the left forefinger into the incision is of great assistance in effecting the separation here and at the back of the hard palate with precision and thoroughness.

With regard to the date at which the flaps are pared, many surgeons do this at the beginning of the operation, as it facilitates the free use of the raspatory in raising the muco-periosteum from without inwards. Mr. Rose, on the other hand, advises that the paring be postponed until the flaps have been detached, as the raw edges are thus less liable to be bruised by the sponges, and with the flaps loosened the margins can be pared with greater accuracy.

While the soft parts are thus separated the hæmorrhage will be free, but always yields to sponge-pressure applied as advised above.

When all bleeding has stopped, the sutures are inserted as before (p. 350), wire or salmon-gut or silk being used here.

Tension may in part be removed by prolonging the lateral incisions backwards.

Mr. T. Smith points out that, in bringing together the halve of the palate, care must be taken to evert the edges of the cleft with a small double hook in passing and twisting up the sutures.

Sir W. Fergusson's Method * (Figs. 119, 120).—This surgeon, finding that even in his hands attempts to completely close the hard palate often failed owing to the contraction of granulations, by which the lateral flaps were drawn back to their original position, introduced the following modification, which he especially recommended for apertures in the hard palate, but which he had used with great success in a complete cleft of both.

Sir W. Fergusson, having pared the edges, divided the palate, both soft tissues, and bone, first with a scalpel and then with a chisel,† about $\frac{1}{4}$ inch from the margin of the gap on each side.

FIG. 119.

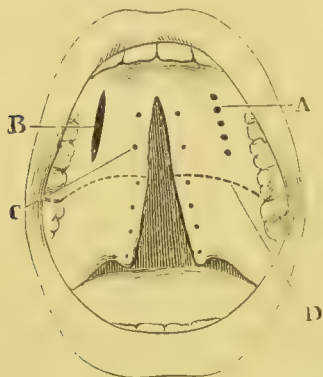
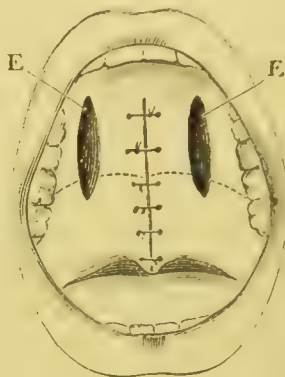


FIG. 120.



- A, Preliminary punctures with bradawl to give line for chisel.
- B, Incisions through bone completed by chisel.
- C, Holes in palate for sutures.
- D, Junction of hard and soft palate.
- E, Lateral openings subsequently filled up by granulations. (Bryant.)

With the chisel pushed up into the nose through each incision, by slight movements from side to side, each lateral portion is prised towards each other until they meet in the middle line. when sutures are inserted between the pared edges of the soft parts. In some cases sutures were inserted not merely into these edges, but were passed through the lateral apertures right across the gap.‡ Hæmorrhage is arrested by plugging the lateral incisions, if needful. Nowadays aseptic gauze is best used for this purpose. Sir W. Fergusson stated his belief that the objections which at first arise to his method are not valid—(1) There is no caries or necrosis; (2) there is no dangerous hæmorrhage; (3) there is less risk of sloughing than by the old method; (4) the lateral incisions heal well. He admits that if, as sometimes occurs.

* *Brit. Med. Journ.*, April 4, 1874. Sir W. Mac Cormac in the same journal (May 20) points out that Dieffenbach and Wutzer had first used a very similar operation.

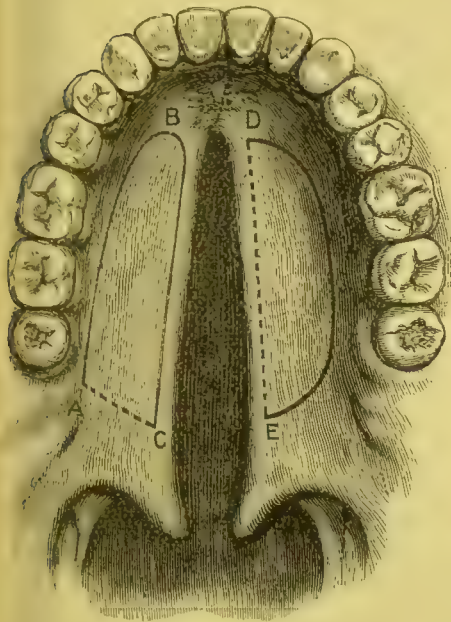
† Preceded in some cases by drilling a line with a bradawl, as in Fig. 119. drawn by Mr. Rose for Mr. Bryant's *Surgery*, vol. i. Figs. 184, 185.

‡ Sir W. Mac Cormac (*loc. supra cit.*) shows that Dieffenbach made use of similar sutures, sometimes securing further approximation by again twisting them up later on.

the vomer is found attached by its lower margin to the palate, it would be difficult to introduce stitches. But approximation alone of the edges would probably convert the gap into a mere chink, avoiding ordinary observation. Other surgeons have, however, found that this operation is certainly attended with the above disadvantages, and that the hæmorrhage and sloughing may be followed by septicæmia in weakly children, and in a region like this which cannot be kept aseptic. It is noteworthy that Mr. Rose, who was one of Sir William's assistants, does not recommend the operation.

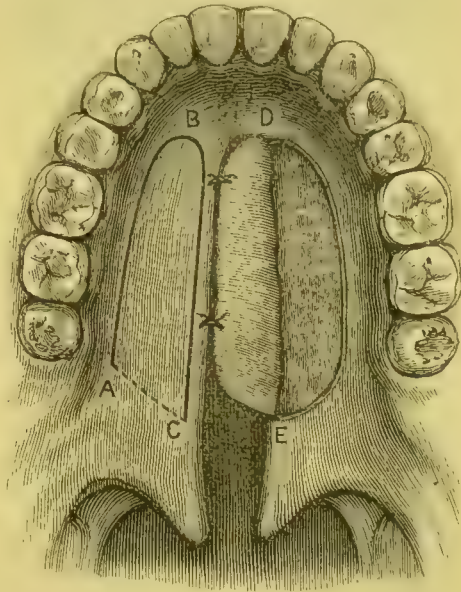
Mr. Davies-Colley's Flap Method for Hard Palate (Figs. 121, 122, 123).—The author of this has found that by his method he can

FIG. 121.



Outlines of flaps marked out.

FIG. 122.

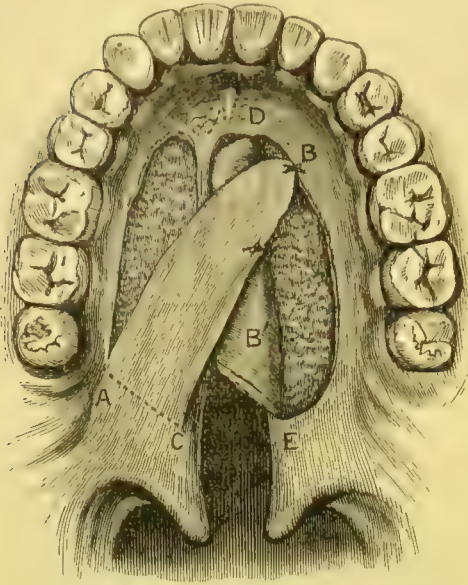


Flap DE dissected up, turned over, and united to opposite side, with its raw surface downward.

operate earlier; thus, he has treated a child successfully at twenty months. Speech is thus likely to be much better eventually. No tissue is cut away. The knife can be used more, and thus less damage is done to the soft parts by the raspator. Again, larger raw surfaces being left, more solid union follows. Finally, the pressure of the child's tongue against the roof of the mouth is likely to be less harmful. A flap (Fig. 121) ABC is turned up towards its base, AC, which is just behind the last molar tooth, its blood-supply from the posterior palatine artery being thus secured. A flap DE (Fig. 122) is then dissected up by a curved incision, turned over, and secured to the opposite side by two chromic catgut sutures. The raw surface of this flap is thus turned downwards, looking to the floor of the mouth. ABC

is then glided over to the left side, and sutured to DE. Fig. 123 shows the final arrangement when ABC is united to the opposite side, leaving in front a raw surface, where it was dissected off, while behind is exposed a little of the raw under-surface of DE.*

FIG. 123.



Flap ABC glided across and united to under raw surface of DE.

temper and intelligence allow of it, the mouth may be regularly syringed or washed with Condyl's fluid or boracic-acid lotion. In other cases it is best to leave the wound quite alone. After the first week the patient may get up, under supervision. There should be no hurry to remove the sutures, which may remain for about seven days in the soft, and about ten in the hard, palate, and there should be no anxiety to look at them early and often.

To make this subject of after-treatment at all complete a few words must be said about the improvement of speech after the cleft has been surgically cured, and the occasional need of an obturator. Even after a complete closure of the cleft much awkwardness of speech is liable to remain, this being, of course, most marked the older the patient is. Parents are often greatly to blame for the little trouble they will take to further the success of the surgeon's efforts, and this refers in many cases to those who have not the excuse of the ignorance and toilsome life of the poorer classes. They too often act as if, because the cleft is closed, no further responsibility rests with them. Again, the patients being usually children, without thought as to the future, and satisfied with the improvement in their deglutition, present many diffi-

* I am indebted to Dr. Wilson Smith for these diagrams of Mr. Davies-Colley's operation. They were copied at a clinical lecture. Since these sheets were printed Mr. Davies-Colley has published his operation, *Brit. Med. Journ.*, Oct. 25, 1890.

culties. Not only has the child to be taught the right way of using its organs of speech, but wrong habits, especially nasal and guttural tones, have to be unlearned. This is only to be brought about by means of systematic lessons and practice gone through regularly day by day for months and even years. No plan will be found better than that recommended by Mr. W. Haward, Clin. Lect. "On Some Forms of Defective Speech" (*Lancet*, 1883, vol. i. p. 111): "The instructor should sit directly facing the pupil; the pupil is made to fix his attention thoroughly upon the face of the teacher, and to copy slowly his method of articulation. This should be displayed by the teacher in an exaggerated degree, every movement of the lips and tongue being made as obvious as possible to the pupil, and the more difficult sounds or movements prolonged for the purpose. Thus, for instance, suppose the word 'sister' were to be practised, the teacher, having filled his chest with a long inspiration, would open his lips and draw back the angles of the mouth, so that the pupil could see well the position of the tongue against the teeth; he could then prolong the hissing sound of the 's,' and, finally separating the teeth as the sound of the 't' in the second syllable issues, allow the pupil again to see the position of the tongue as the word is ended. Or, for another example, take the word 'lily.' Here the teacher would separate the lips and teeth, so that the tongue would be seen curved upwards, with the tip touching the hard palate; the word would then be pronounced with a prolongation of each syllable, the teeth and lips being kept open, so that the uncurling of the tongue and its downward movement are clearly seen. So, again, in teaching the proper method of sounding such words as 'wing' or 'youth,' much aid is given by keeping the lips somewhat separated, so that the relation of the tongue and palate can be made manifest. The pupil must be made to fill his chest,* and then to imitate as closely as possible every movement and sound of the teacher, and this may sometimes be assisted by making the pupil feel, with the finger as well as observe with the eye the relative movement and position of the teacher's tongue and palate. There should be no other person in the room to distract the pupil's attention. It is best to continue the exercise for a short time only, and to repeat it frequently, rather than to fatigue the child by a long lesson; and it is a good plan to take an ordinary elementary spelling-book, and to mark the words which the pupil finds most difficult to pronounce,† so that these may be especially practised."

With regard to the question of obturators and vela, in cases where it has been found impossible to close a very wide cleft, or where it is evident that even after a successful operation the palate will be so tense and short as to be quite unable to touch the

* Opening the mouth widely and learning to keep the tongue down on the floor of the mouth are two points to be early and strenuously insisted upon. The patient should practise them before a looking-glass.

† Especially those containing the letters t, b, d, k, g, s, z and l. (Rose.)

pharynx, and so shut off the nose from the mouth, an obturator may be required. A very useful form, that of Dr. Suersen, of Berlin (*Brit. Med. Journ.*, 1882, vol. ii. p. 875), and several others, are described by Mr. Newland Pedley (*Guy's Hosp. Reps.*, 1894). The whole question is very fairly dealt with, and many useful hints are given as to the improvement of speech in these cases. The chief disadvantages of instrumental aids are that if fitted early they will require frequent alteration; on the other hand, unless worn early they will be of less service. Just the same care in overcoming faulty habits of speaking and in teaching correct ones is required now as after a successful operation. But it is only fair to remember that while surgeons are naturally anxious to close all clefts, an operation or a series of operations which have succeeded in uniting the gap and improving deglutition may not be successful in restoring speech. For a real success in this direction the palate should be long enough, mobile enough, and united sufficiently early in life. It is impossible, when an honest surgeon looks at some of his results where a wide cleft has been completely closed by two or three operations, with the result of a palate short and seamed with scars, the soft palate especially being tense, stiff, and almost immobile, to deny that there is much truth in Mr. Pedley's words that here, "as far as correct articulation is concerned, the operations have only increased the difficulty of necessary treatment by artificial means, and I think that staphylorrhaphy was contra-indicated if the patient could have obtained a velum."

Causes of Failure.—1. Vomiting; * 2. Premature cutting of sutures from tension; 3. Hæmorrhage. Serious hæmorrhage in children, either at the time or later, is very rarely met with, but it is otherwise in adults.

Mr. H. Marsh (*Clin. Soc. Trans.*, vol. xi. p. 71), in the case of a patient aged twenty-one, was compelled to plug the posterior palatine canal owing to severe hæmorrhage on the sixth day.

The hæmorrhage recurred twice, the last being as late as the fourteenth day, and was arrested on each occasion by the following means: "Searching with a sharp-pointed probe, passed through the lateral cut, about $\frac{1}{3}$ inch in front of the hamular process, which can be easily felt through the soft palate, and about the same distance directly inwards from the wisdom tooth, I felt, after two or three attempts, that I had fixed the probe in the orifice of the canal, and at the same time the patient screamed with pain, when the large posterior palatine nerve was touched. A wooden plug, made by sharpening a piece of firewood, was then pressed firmly into the canal, by holding it in a pair of strong forceps with its point looking upwards, and a little backwards in relation to the roof of the mouth. Directly the plug was introduced the bleeding ceased." The recurrence was due to the plug slipping out.

4. Whooping cough. 5. Exanthemata. 6. The child putting a finger into the wound. 7. Swallowing of solid food. 8. Feeble condition of the child, with congenital syphilis, &c.

* Mr. Mason (*Brit. Med. Journ.*, 1872, vol. i. p. 14) gives the case of a child, aged nine, where the vomiting of two lumbrici led to failure.

With reference to the above causes of failure, while, very occasionally, hæmorrhage at the time of the operation in a weakly child, prolonged vomiting, want of supervision after the operation, may be the cause, in the very great majority of cases the failure is due to some neglect of the precautions which are recognised as essential. They are (*a*) insufficient relief of tension on the sutures by inadequate use of the raspatories in freeing the muco-periosteal flaps, or when the lateral incisions are made. (*b*) Unskilful paring of the edges by which either not enough is done, the cleft not being completely pared, or too much is removed and the tension thereby increased. (*c*) Bruising of the edges from unskilful manipulation with instruments or sponges, difficulty in passing the sutures, &c.

REMOVAL OF GROWTHS OF THE PALATE.

Growths here, though rare, have a special interest, from their position, and may thus be briefly noticed. For a good account of them I would refer my readers to a paper by Mr. Stephen Paget (*St. Barth. Hosp. Reps.*, vol. xxii.), in which the following points are brought out: (1) The chief groups are the polypoid and warty, the adenomatous, the sarcomatous, and the carcinomatous; this last including the encephaloid, which are very rare, and the epitheliomatous, commencing in irritation here as elsewhere. (2) That it is hardly possible to tell beforehand to which group the growth belongs. (3) Many of them, especially the adenomata, can be shelled out with surprising ease. (4) That the growth itself should not be cut into.

In the case of large and vascular growths the aids of splitting the cheek or performing a preliminary laryngotomy and plugging the fauces (p. 384) may well be resorted to. In the case of a growth of the hard palate, clipping it away with scissors and scraping the bone will be insufficient; the bone around should be freely removed with chisel and gouge, or the palate portion of the superior maxilla removed. In a case which I saw in consultation with Dr. Wilson, of Haverfordwest, where the growth not only bulged in the palate but in the neck as well, this excellent surgeon operated successfully by two incisions, one in the palate, and the other parallel with the large vessels at the angle of the jaw.

From what I have seen of two cases of epithelioma of the palate, starting from the alveolar process, and in one case certainly originating in an old syphilitic sore, no time should be wasted with such means as the application of acids, or the cautery, and I think that removal of the bone itself by some such operation as that of Maisonneuve (p. 315) is preferable to attacking the growth with gouge or chisel.

CHAPTER X.

REMOVAL OF THE TONGUE (Figs. 124, 125).

THE day when the belief is accepted, and acted upon, that cancer of the tongue, like many other epitheliomata, has a pre-cancerous stage, and that this is the stage in which we ought to operate, will be a happy one for hundreds of patients and for the results of surgery. Of all the painful deaths by which men leave this world there are few more miserable and distressing than one which closes life by cancer of the mouth. And yet, though in the case of the tongue this most important stage is, from the position of the organ which it attacks, peculiarly under our eyes and lies open to our examination and detection, how frequently it is overlooked. I have treated of this malignancy and the other practical points above given, in detail elsewhere (*Guy's Hosp. Rep.*, 1889, p. 245).

Before describing the different operations it will be well to say something with reference to two or three very practical points which rise up with every case of tongue-cancer, a form of cancer which, it must be remembered, is very frequent and increasing in frequency;* which attacks all ranks of life; which, after its early stage, is especially malignant;† in which, finally, an operation is as much dreaded and deferred by men as one for carcinoma mammæ is by women.

A Pre-cancerous Stage.—However tongue-cancer begins, it passes through the above stage, *i.e.*, a stage (the duration of which is unknown, and varies extremely) in which inflammatory changes only are present, viz., ulceration and other changes in the epithelium, not amounting, as yet, to epithelioma, but on which epithelioma inevitably supervenes. The boundary line between this pre-cancerous stage and cancer is extremely narrow; the duration of this stage may be, and often is, extremely brief.

* Amongst common cancers—*e.g.*, of breast, rectum, uterus, &c.—cancer of the tongue stands about third, although so rare in women. Mr. Barker, in his carefully worked out article on "Diseases of the Tongue" (*Syst. of Surg.*, vol. ii. p. 578), gives a series of tables showing that in the last thirty years there has been a steady increase from 2·6 to 11·5 per cent.

† This is shown in the following facts: (α) The rapidity here is quite different from other epitheliomata. Epithelioma, usually thought a slow cancer, here, in a moist, warm cavity, much irritated, and never dry and warty, is terribly rapid. (β) Gland invasion is here not only certain, but inevitably early as well.

- Aids in recognising this stage: (1) The duration of the ulcer. (2) Its obstinacy to treatment. (3) The age of the patient. (4) Absence of any induration or fixity.

Questions Arising before Operation.

The operating surgeon will often be called upon to give an answer to the two following questions: Will the disease be permanently cured? If a permanent cure is impossible, will life be bettered and prolonged?

A. Will the disease be permanently cured?

Really permanent cures are, as yet, too few, 10 per cent. of cases operated on (Barker, *loc. supra cit.*, p. 604); 13 per cent. (Butlin).^{*} I have stated above that in epithelioma here invasion of the glands is not only certain but inevitably early as well. Mr. Hutchinson (*Brit. Med. Journ.*, vol. ii. 1891, p. 1190) draws attention to the following facts, which cannot be emphasised too strongly. Gland infection here begins almost from the very day that the sore assumes suspicious features. Again, lymphatic glands may become involved through ulcers of the most insignificant size and of the briefest duration. Lastly, the same authority points out that cancer germs may remain latent in the lymphatic glands for several years and then evolve disease. Before leaving this subject I would earnestly impress upon my younger readers that invasion of the glands is here not only certain, usually early, but also now peculiarly baneful, owing to (1) the way in which epithelioma infects the glands—*inflammatory cells as well as those of cancer, passing from the primary growth if ulcerated, as it usually is, into the glands*; and (2) *the great importance of the structures amongst which the cervical lymphatic glands lie*. When epitheliomatous glands are operated on the following conditions interfere with a thorough extirpation of the disease: (a) the number of the glands and the abundant communication between the different groups, the importance of the structures closely adjacent to the deeper ones, and the fact that the glands may be affected, and yet so minute as to escape the most careful operator. (β) The presence only too often of inflammatory cells as well as of malignant deposit in the glands so mats them to adjacent parts as to make it quite impossible to really extirpate the glands. Inflammatory softening having set in leads to their breaking down during attempts at their removal, with the result that shells, still the seat of cancerous foci, are left behind. These relics, owing to the vascularity of the surrounding parts, do not die, but preserve sufficient vitality to act, a little later, as centres of recurrent disease.

The explanation of the very small number of permanent recoveries after removal of tongue-cancer is not altogether to the credit of our profession. Patients and we, alike, are too often both to blame. The gravity of the disease is overlooked,

^{*} *Dis. of the Tongue*, p. 295. Mr. Butlin's percentage is calculated from seventy cases. He is inclined to doubt whether a larger number of cases would afford so good a percentage of recoveries.

the time of the "pre-cancerous stage" is lost. Because tongue-cancer is so often preceded by syphilis, or local irritation, the practitioner diagnoses the above, and suggests them as the essential part of the mischief: "give drugs another chance"—*e.g.*, potassium iodide, mercury, caustics.* To these there are, in nearly every case, the strongest objections in the pre-cancerous stage. Time is lost, strength is lost, and the patient is lulled and befooled, while all the time the vascularity and irritation all around the ulcer are increased. Furthermore, the patient is in part responsible for the delay, as he very naturally dreads the operation, exaggerating its danger, painfulness, and the supposed inevitable loss of speech. We shall never be able to successfully combat the above till (1) the importance and value of the pre-cancerous stage are recognised; (2) getting cases of tongue-cancer early.† we are enabled to assure the patient that removal of one-half of the tongue will be sufficient, and that half can be safely and usefully spared to him.

B. *If a permanent cure is impossible, will life be bettered and prolonged?*

Cases which are not operated on die within eighteen months, many in twelve months. An operation wisely planned and well carried out often gives a gain of six or eight months. This is a gain not only of time, but also of comfort. Death by glandular recurrence in the neck is less painful and noisome than death by mouth-cancer. No one who has seen much of tongue-cancer will have any difficulty in answering the question which of the two is most painful to the patient and distressing to those around him—tongue-cancer with its horrible fœtor, profuse and foul salivation, its pitiless, incessant, weary, racking aching of tongue, ear, face, and teeth, or recurrence in the cervical glands, an alternative in which the patient is often able to work up to near the last, and, till towards the close, is free from the agonising tenderness, the stinking fœtor, the dribbling of foul saliva (not only half-poisoning the patient, but rendering him noisome to others‡),

* "While a careful thorough application of nitric acid or acid mercury nitrate is perfectly justifiable in certain cases, and may be highly beneficial, the use of caustics frequently repeated at short intervals is here futile and perilous. For medical men to waste time with this treatment should at the present day be almost criminal, for such dallying with drugs and local applications can only lead to cultivation of cancer, and most miserable and often untimely deaths" (article, *loc. supra cit.*, *Guy's Hosp. Rep.*, 1889).

† If a sore has been persistent for longer than three months, permanent recovery is very doubtful. If it has persisted for over six months, if more than one-third of the tongue is invaded, if the floor of the mouth is involved, permanent recovery is well-nigh certainly hopeless.

‡ "Recalling the 'male gratus amicis' of Dean Swift. Who has not seen such cases, the close of whose life brings, week after week, days without hope and nights without rest, and has not longed exceedingly for a wider recognition of the pre-cancerous stage of tongue-cancer, and for earlier operations in it?" (*Guy's Hosp. Rep.*, *loc. supra cit.*).

and the slow starvation day by day of tongue-cancer. Where an operation is certainly attended with risk, the patient in facing it may be relieved by the assurance that a life prolonged in hideous misery and constant agony is worse than death following close on an operation. "When a man has only, suppose, two or three years to live, it is no small advantage if at least half the time can be spent in comfort rather than in misery, and in profitable work rather than in painful idleness" (Paget). If a patient cannot make up his mind to an operation and is losing precious time, he should be warned, without being unduly frightened, of the state of things, alluded to a few lines above, which will inevitably follow. Usually, as soon as this sets in—*i.e.*, when the condition of the tongue renders him a nuisance to himself and others with the disgusting factor, the constant dribbling of foul saliva which cannot be swallowed, the weary aching day and night, lit up into agonising flashes when the parts are touched or moved—the patient becomes willing to run any risk. But, too often, by this time, if the glands are not already enlarged, the mischief has reached the floor of the mouth or the alveolar mucous membrane by extension, though not yet perhaps with ulceration.

Operations.—The following four will be carefully described—*viz.* :

- | | |
|---------------------------------|------------------------------------|
| (i.) Whitehead's. | (iii.) Kocher's (Fig. 125). |
| (ii.) Syme's (Fig. 125). | (iv.) The Écraseur. |

With these, certain aids—*e.g.*, slitting the cheek, preliminary laryngotomy, and ligature of the linguals—will also be considered. One or two other methods will then be briefly alluded to.

While the above operations—and I allude especially to the first three—give a choice which will enable the surgeon to meet any case of tongue-cancer; whichever is chosen must be completely carried out: "niggling" operations lead inevitably to return and accelerated growth in the tongue itself.

(i.) **Whitehead's.**—The advantages of this are very great. They are: (*a*) The transverse section of the body of the tongue can be placed, deliberately, well behind the growth. However far behind the growth the loop of the *écraseur* is placed before the operation, and however securely it seems to be retained *in situ* by large curved needles, as the loop is tightened up, owing to the enormous strain which is gradually applied, the needles and the loop are forced forwards nearer and nearer to the growth. Now the neighbourhood of this is all ready to become the seat of malignancy. All around the growth the epithelial columns are ready to dip down into the vascular connective tissue beneath, on which in health they never encroach. Again, the parts around are loaded with inflammatory cells, soft and vascular. If, as is very likely, owing to the tremendous tension to which it is submitted, especially when the parts are very soft, the loop comes crushing into this neighbourhood and makes the section here, the indipping

processes which extend for some distance around the actual epithelioma may, owing to the vascularity and inflammation consequent on the operation, break out into speedy recurrence. Again, the insertion of the needles which are intended to keep the loop well behind the growth is not always an easy matter, especially if the growth is far back, and if the front teeth are well developed whilst the molars and pre-molars are too deficient to allow of wide opening of the mouth with a gag. (b) The resulting wound is very clean, there being very little laceration and no charring. The slight decomposition which would take place from an extensive operation, even with scissors, is readily checked by the use of creolin, &c. The advantage of this in saving a patient, whose vitality is already lowered, from the depressing effects of being liable for days to breathe and swallow with a fetid sore in his mouth, in securing rapid granulation and healing, and thus enabling the patient to be early propped up, and soon to leave his bed, must be obvious to every surgeon who knows how great the risk is of fatal septic bronchitis in these cases. For the same reason secondary hæmorrhage is unknown. (c) The instruments required are extremely simple and few, as will be seen from the account of the operation.

The Operation.

It is most essential that the anæsthetic should be in the hands of a man who can be thoroughly trusted. It is often taken badly in these cases, with much dyspnœa and restlessness at first; and, during the operation, owing to the open mouth admitting much air, and the fear of interfering with the operator, the patients often "come to" frequently. The only thing is to get them well under at first; later on it will be well not to keep them too much under the influence of the anæsthetic, in order that, the sensibility of the larynx not being lost, the blood may not enter the air passages. The administrator must watch the tint of the lips, the veins in the cheeks, and know when a little blood is only safely, though noisily, bubbling at the back of the fauces, and when it is getting into the trachea. I look upon the administrator of anæsthetics in these cases as nearly as important as the operator. Two reliable assistants are needed who understands the steps of the operation, one to take the gag in charge, and to sponge when needed, and the other to hook back the corner of the mouth with two fingers while he is ready to sponge, and thus, with the position of the head over to this side, enable the blood to escape freely from the wound into the cheek and out of the mouth, with the aid of deft sponging. Two nurses should be ready to supply sponges: these being absolutely clean, soft, thoroughly wrung out of iced Condy's fluid, and firmly secured on holders. The following instruments should be close to the operator's right hand—viz., scissors.*

* Mr. Whitehead, hearing in 1881 that I had twice operated by his method, kindly sent me a pair of his scissors. They are rather longer than usual, perfectly flat, very sharp up to the tips, which are square and blunted. Mr. White-

a few pairs of Spencer Wells' forceps, curved on the flat, a needle in a handle, threaded with stout silk, and some medium-sized ligatures of carbolised silk.

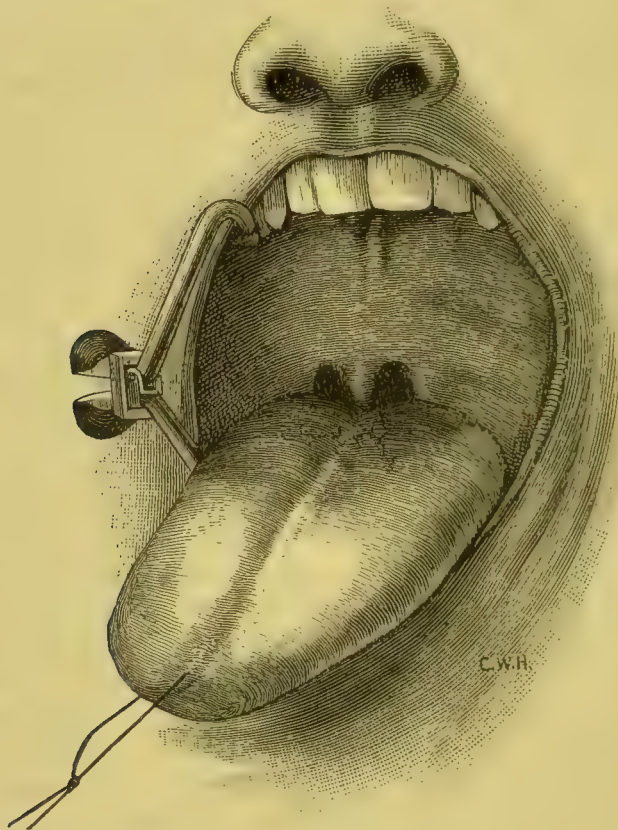
A good light is absolutely essential. Daylight close to a window is far the best. If it is needful to operate when the above cannot be obtained, as in a succession of foggy November afternoons, a good lamp light, concentrated by a laryngeal mirror, will be useful. In making arrangements for a good light, the surgeon will remember that, while the removal itself takes but a short time, getting the patient under the anæsthetic, and keeping him under its influence, often render the operation much prolonged. It may not be superfluous to add here that this is an operation which calls for coolness and decision on the part of the operator, and for promptness with their help on the part of all those who assist. No crowding on the operator, no obstruction to the light by bystanders, should be permitted for a moment.

Preliminary Laryngotomy.—The question of the advisability of this operation now arises. It forms no part of a "Whitehead" proper. The operator who introduced the scissors-method, and whose success with it is so well known, never, I believe, uses a preliminary laryngotomy. In my first 6 cases I followed him closely. In the later 33 I have performed laryngotomy on many occasions. With a wider experience, I am led to think very highly of this preliminary step, and of the plugging of the back of the mouth, which it renders safe, and I do so for this reason. With the fauces plugged, and the patient breathing through a laryngotomy cannula, the surgeon can neglect the hæmorrhage more, can so operate more deliberately, and thus (and this is the value of this preliminary step in my mind), at every step of the operation, can have the parts more thoroughly sponged dry, and thus be enabled throughout to keep more surely wide of the disease. In other words, I do not dread the hæmorrhage which accompanies a scissors-operation for itself, but because it is liable, in spite of careful and prompt sponging, to obscure the field, and thus lead to cutting dangerously near the growth—a danger especially likely to happen if the hæmorrhage is at all free, if the parts cut are very much softened, and if the patient is not taking the anæsthetic well. For these reasons, I am inclined to recommend a preliminary laryngotomy, with plugging of the fauces, in these cases: (1) When a surgeon who values Whitehead's operation is doubtful as to his means of meeting hæmorrhage. (2) When the growth extends beyond the middle of the tongue, into the posterior third. (3) When the floor of the mouth is at all involved. In growths limited to the anterior half of the tongue, unless there is much fixity, laryngotomy is not needed, for, as will be seen below, sufficient of the tongue in such cases, after very little use of the scissors, comes right out of the mouth.

head's latest account of his operation, with his results in a hundred cases, will be found (*Brit. Med. Journ.*, vol i. 1891, p. 961).

If it is decided to perform laryngotomy, this operation is done as at p. 384, and a soft clean sponge, dusted with iodoform, is tied with silk into appropriate size and fixed at the back of the fauces, the silk being brought out of the mouth and held by a finger of the assistant who has charge of the gag. This sponge must be pressed well back, and care taken that it does not draw back and down the base of the tongue, or it may cause some difficulty in securing the linguals when the transverse section of the tongue is made far back. The anæsthetic is now continued through the

FIG. 124.



tube, an additional advantage, brought about by the laryngotomy, as the administration of the anæsthetic does not interfere with the field of operation. So very little sloughing and swelling of parts follows on Mr. Whitehead's operation that the laryngotomy tube may usually be removed as soon as the patient is back in bed, and has "come to" comfortably.

Whether laryngotomy is performed or not, the patient, being propped up, is brought quite to that side of the table on which the surgeon stands. A gag* is placed on the side of the mouth

* Of these I prefer Dr. F. W. Hewitt's modification of Mason's gag as the readiest and most efficient in case of need, and, on the whole, the best all-round instrument in the administration of anæsthetics. Below the two branches run two tubes, by which A.C.E. mixture or chloroform can be administered without

opposite to the growth, and the mouth widely opened. The tongue is then transfixed on the diseased side well back in its anterior third, with a needle in a handle loaded with stout silk; this is looped and knotted, and the tongue thus well drawn out of the mouth. The surgeon then, where one half can be spared, with a sharp-pointed bistoury, splits the tongue longitudinally along the raphé, to a point thoroughly well behind the growth. It has been said that leaving half the tongue is useless, the part left being but little under the patient's control. I am of an opinion entirely different, for reasons given below.

The diseased half or the whole tongue being drawn well out of the mouth by means of a stout silk loop or reliable tongue-forceps, the surgeon next divides with scissors the mucous membrane between the tongue and the alveolar process, keeping close to the bone so as to be wide of the disease. The anterior pillar of the fauces is next divided. While the above steps are taken the two assistants sedulously sponge away any hæmorrhage into the hollow of the cheek and out of the mouth, the cheek being retracted as above directed. Careful sponging, and sponge-pressure on bleeding points, are most essential if the surgeon is to cut wide of the disease.

If the disease has implicated the frænum and its vicinity, two or three of the lower incisors should be drawn so that the scissors may be introduced on a level with the disease. If this is not done, the scissors have to be dipped in over the teeth in an awkward way, and one which, as soon as bleeding occurs, makes it impossible to make sure of getting below the disease. The scissors can be introduced with much greater facility, and used to much better purpose, if a gap is made in the teeth. These can be kept, and fitted to a plate later on by a dentist.

When half of the tongue has been freed all round, the muscles between it and the floor of the mouth are cut through with a series of short snips until the diseased half is separated on the level of the lower part of the jaw, as far back as is needful. During this stage oozing will take place, and one or two small arteries jet with varying freedom in different cases, but these will yield to pulling steadily on the tongue and to firmly applied sponge-pressure.

The tongue having been freed horizontally up to a point well behind the disease, the transverse section is now made, and here I have found the following precaution useful:—Instead of cutting straight across the half and trusting to being able to secure the lingual on the face of the stump, a step by no means always easy of accomplishment, owing to the artery being often at once obscured by a small pool of blood, and to the not infrequent softness of the tissues in these cases, I cut a deep groove through the

any interference with the surgeon. A gag is still needed for edentulous jaws. The best here is a dentist's gag.

tough mucous membrane of the side and dorsum, and tear through the softer muscular tissue with the closed scissors or a steel director till the lingual nerve and artery are seen, next, having applied a long-bladed pair of torsion-forceps to the remaining tissues, cut away the half of the tongue in front of the forceps, and then twist or tie the lingual artery which has thus been secured.*

If it be needful, the surgeon then proceeds to deal with the other half of the tongue, a step which is much facilitated by the room given for manipulation by the removal of the first half.

Removal of Half the Tongue.—On this subject I may quote again from my article in the *Guy's Reports*, p. 252: "(1) The removal of half the tongue is suitable and strongly called for in certain cases. (2) That such an operation, performed in fitting cases, leaves the patient with an organ which is (a) safe from recurrence, (β) a most useful one in speaking, swallowing, &c. (3) That it is only by operating early in these cases, and by thus being in a position to promise the patient that the less severe operation will be sufficient, and will give him immunity from disease and leave him with a most useful organ, that we shall ever attain to better success in our operations for cancer of the tongue, removal of the tongue being a mutilation especially dreaded and deferred by the patient." Two cases are then given in detail in which I had removed half the tongue. *The condition of the tongue subsequently to removal of one half longitudinally.*—Having seen the male patient lately, over three years since the operation, a short account of the condition presented by his tongue and mouth will not be out of place.

On looking into the patient's mouth, the tongue is seen to be directed constantly over to the left side by the unbalanced fibres of the right half, the tip especially being curled round to the left side and a little backwards. The mucous membrane on the floor of the mouth on the left side is, as is always so in these cases, loose and prominent from the constant dragging on it of the remaining tongue. *Mobility.*—When the patient is asked to protrude his tongue beyond the lips, there is nothing in the mouth to prevent his tongue from doing so; the tongue is pushed out between the lips, but owing to its tendency to curl round towards the left it does not come beyond them. From the same cause Mr. C. is unable to touch the right commissure of his lips with the tip of his tongue. When asked if he can touch the hard palate with his tongue, he can do so when the teeth are half an inch apart, not when the jaws are widely separated. *Speech.*—Mr. C.'s own account is that he is always intelligible, save when "excited, as in talking politics." His voice is loud and ample. His speech is clear and intelligible, save when one or two consonants, especially two dentals, requiring rapid touching of the incisors or hard palate by the tip of the tongue, succeed each other closely, as in the word "literal." *Taste.*—This, the patient says, is

* If any difficulty occur in dealing with a divided lingual, especially if the tongue has been divided far back, a suggestion of Mr. Heath's will be found most useful—viz., to hook one or two fingers into the pharynx over the stump of the tongue, and to draw this forwards, thus at once arresting the hæmorrhage by pressure, and bringing into view the bleeding point.

absolutely unimpaired. *Mastication*.—It is here only that Mr. C. allows that any difference is to be noticed since the operation. Thus in certain actions, *e.g.* chewing up a bitten piece of apple, manipulating a portion of herring so as to avoid swallowing small bones—in such actions as these he states that “the left half of his mouth does not act as well as the right, the latter having a little more work to do.”

Where, in fitting cases, it is possible, after splitting the tongue, to leave one-half of it, this part will be found most useful in speaking, swallowing, &c., and I am further most strongly of opinion that if patients could be assured that, by early operation, half only of the tongue would require removal, they would submit much more readily to an operation which they dread so peculiarly, and to the grievous putting off of which is due the very small percentage of permanent cures.

Slitting the Cheek (Fig. 125).—This step is an excellent one. It may be made use of, in men especially, in cases where the disease is situated very far back, extending close to or on to the anterior pillar of the fauces, where the hæmorrhage is expected to be especially free, where the light is unavoidably very bad, or where there is unusual difficulty in getting the jaws well apart. The cheek is slit as far back as the anterior border of the masseter, the facial artery and other small branches being secured at once. The parts require most careful adjusting afterwards, especially at the corner of the mouth, where, from the dribbling of saliva, primary and exact union is not always secured.

Preliminary Ligature of the Linguals.—This step was very largely practised by Prof. Billroth (*Clin. Surg.*, Syd. Soc. translation by Mr. Dent, p. 113). Unfortunately he expressed no opinion as to its value, merely stating that he ligatured the artery twenty-seven times (apparently in all as a preliminary step), and that no secondary hæmorrhage ever followed, and that the wound always healed satisfactorily.

I have never taken this precaution myself, and I do not recommend it, for the following reasons:—(1) In three cases in which I know of this precaution having been taken, the hæmorrhage was as free as in the usual operation with scissors, performed without any such preliminary.* (2) I think that an experience derived from operations in thirty-nine cases justifies me in saying that if the operation with scissors be performed with attention to the details given above, the hæmorrhage is not so difficult to deal with as to require this precaution.† (3) The ligature of both linguals is by no means an operation that can be done quickly,‡ and requires a good light. It may thus take up a good deal of the time required for dealing with the disease of the

* The operations were here performed by two of my colleagues, and there could be no doubt that the vessels were secured.

† In writing this I am taking it for granted that the surgeon will be aided by helpers as apt and ready as I have been fortunate enough to find.

‡ The operation is fully described, and its difficulties entered into, at p. 470.

tongue itself. If it be answered that diseased glands can be dealt with at the same time and by the same incisions, I must state, in no contradictory spirit, that I am of a distinctly contrary opinion. Removal of epitheliomatous glands requires of itself much time and painstaking, lying, as they do, in long chains, and in relation with most important structures. If they are to be removed with that thoroughness which alone justifies any attack on them, this should be done with the full allowance of time and the undivided attention which are given by a separate operation, either before or after that on the tongue.

Mr. Treves (*Operative Surgery*, vol. ii. p. 201) is a strong advocate of ligature of the linguals before performing Whitehead's operation, for the following reasons: (1) Without it the hæmorrhage is sufficiently copious to hamper the operator. That the hæmorrhage is free with the scissors alone, none will deny. But it may be safely met by a cool and deliberate operator if the patient is kept well propped up, with the head to one side and the cheek on that side open and retracted. Of the imperative need of a skilled anæsthetist and assistants I have already spoken. (2) That it enables the surgeon to deal with enlarged lymphatic glands, perhaps not to be felt through the skin. I freely admit the importance of this, a matter to which I have drawn attention (p. 361), and elsewhere. Personally, I should prefer to remove the tongue first, and then, if the patient's condition admitted of a further, and very possibly, a prolonged operation, to remove the glands. (3) Mr. Treves states that ligature of the linguals is easy, and that a period of seven minutes is a fair average of the time required to secure each vessel. My reply to this is very simple. The advice I give in this book is not, for one moment, intended to apply to surgeons of Mr. Treves' operative experience or anything approaching to it.

(ii.) **Syme's Operation** * (Fig. 125).—This consists in dividing the symphysis menti and then removing the whole tongue and floor of the mouth with knife or scissors, or, partly with one of these, and partly with the *écraseur*.

It is a far more serious operation than the one already given, and often involves prolonged after-treatment, owing to the tardy union of the jaw. It should be reserved for those cases in which the ulcer involves the floor of the mouth, or in which, in addition to an ulcer on the side, a hard mass of infiltration can be felt in the substance of the organ. Where this operation is contemplated in an aged or broken-down patient every attempt should be made to improve the general health previously. An anæsthetic being

* *Lancet*, 1858, vol. i. p. 46, and vol. ii. p. 168. See also the account by Dr. Fiddes of his case, *Edin. Med. Journ.*, vol. iv. p. 1092. As a proof of the severity of this operation, both of Prof. Syme's first two patients died. When the symphysis must be widely removed as well the danger is much increased, chiefly owing to the impossibility of wiring the jaws here and the greater difficulty in taking food.

given, and a preliminary laryngotomy performed, if needful,* the patient's head and shoulders are raised, and the surgeon divides the soft parts of the chin, as far down as the hyoid bone, if the soft parts in the floor of the mouth are much implicated. The vessels being secured, the jaw is drilled below the teeth $\frac{1}{4}$ inch on either side of the middle line and then sawn through.† The mouth must be kept carefully sponged out, and the halves of the jaw being forcibly retracted, the tongue is well drawn out by a loop of silk, the mucous membrane snipped through between the tongue and the alveolar process, and the anterior pillars next divided. The genio-hyoglossi‡ and genio-hyoids are next divided, and the tissues in the floor of the mouth separated as deeply as necessary with the scissors or blunt-pointed bistoury aided by the finger, partly by cutting and partly by tearing, any vessels that require it being tied or twisted. The tongue being thus freed laterally and below as far back as is needful, the transverse section is made, one-half at a time, with the precautions recommended at p. 367.

The floor is now carefully inspected, and any suspicious patches or enlarged glands most carefully removed. In raising the former, before using the scissors, a tenaculum is often very useful. If it be preferred, though I in no way recommend it, as soon as the attachments of the tongue to the floor and sides of the mouth are sufficiently divided, the transverse section can be made with an *écraseur*, the loop of which is slipped over the tongue and kept in position by two curved needles as at p. 374.

The two halves of the jaw can then be wired, but to promote speedy union a cap of vulcanite or silver should, later, be fitted on to prevent displacement of the fragments. A drainage-tube should be brought through from the mouth to a point just above the hyoid bone, before the soft parts are united with sutures.

(iii.) **Kocher's § Method, by Lateral Infra-maxillary Incision** (Fig. 125).—This operation, like the last, is a severe one; it also opens up freely the connective tissue of the neck. It is said to have the great advantage of enabling the surgeon to deal with mischief far back in the tongue and at the same time of removing enlarged sub-maxillary glands. The statement that the operation can be performed aseptically must be received with much caution,

* As a rule this step is not required. When the divided jaws are held well asunder, the blood flows freely out of the mouth.

† By some it is advised to saw this somewhat angularly instead of vertically to promote interlocking and union of the fragments. As, however, necrosis may follow this as well as the other form of bone-section, the longer time that it entails is scarcely worth giving.

‡ If only one-half of the tongue needs removal—a rare contingency in the cases which call for this operation—the complete separation of these muscles and the consequent danger of the falling back of the tongue will alike be avoided.

§ *Deut. Zeitsch. f. Chir.*, Bd. xiii. 1880. Mr. Barker was the first, I believe, to draw the attention of English surgeons to this operation ("Diseases of the Tongue," *Syst. of Surg.*, vol. ii.).

It is impossible to cleanse thoroughly the naso-pharynx, antrum, and other regions which lie near, and the plugging of the nostrils with aseptic wool and packing the wound with gauze, which will need changing, involves much misery to the patient. The mouth being disinfected with a 1 in 3000 perchloride of mercury solution, and a preliminary laryngotomy performed, an incision is made from just below the symphysis down to the hyoid bone, and following the digastric muscle back to the anterior edge of the sterno-mastoid, and then up to near the lobule of the ear. The flap thus marked out of platysma and fasciæ is then turned up, and the facial artery

FIG. 125.



The incisions on the nose are those of Ollier for the removal of naso-pharyngeal polypi, p. 315. Below are seen three for the removal of the tongue—viz., that for slitting the cheek, and that of Syme's operation. The third, that of Kocher, should have been brought further forward, curving up towards the chin.

tied. The sub-maxillary region is then thoroughly cleaned out and the lingual artery secured beneath the hyoglossus. By cutting through the mylo-hyoid muscle the cavity of the mouth is now freely opened into, and the tongue brought out through the wound and divided as far back as is needful, one-half being removed after splitting the organ, or the whole tongue removed, the opposite lingual being tied if needed.

The large wound is then carefully packed with strips of anti-septic gauze, a drainage-tube being first inserted. The patient continues to breathe through the laryngotomy-tube until the wound and mouth are quite sweet, and thus there is no danger of septic broncho-pneumonia.

If it be desired to conduct the operation as strictly anti-septically as possible, before it is begun plugs of salicylic wool

must be placed in the nose, the cavity of the mouth well washed out with 1-3000 mercury perchloride solution, and irrigation used at the operation and at each dressing. As, however, it is impossible to render aseptic the closely contiguous cavities of the posterior nares and pharynx, and as the patient will require feeding at regular intervals with a nasal tube, I would prefer to trust to sufficiently frequent changes of the gauze with which the wound is plugged, dusting in creolin and powdered boracic acid, painting on with a camel's-hair brush iodoform and ether, and securing free drainage by a drainage-tube which has one end brought out of the mouth and the other at the lower and posterior angle of the wound, both lodged in aseptic dressings.

Several English surgeons have lately drawn attention to Kocher's method, already alluded to, of packing the wound with antiseptic gauze and bringing a drainage-tube out into the sub-maxillary region. Mr. Butlin gives, with especial care, the details with which this method has been employed by Kocher himself, who lost only one patient from the operation in fourteen cases, and by Billroth, whose results, published by Woelfler, show the last seventeen cases thus treated to have been all successful.

I have not myself made use of this method, for these reasons: I consider (1) that other means give as good results, and in a way more agreeable to the patient, and I may add here that, out of thirty-nine cases of Whitehead's method, I have only lost three* from the operation. (2) That this method of packing with gauze does not, and cannot, give absolutely reliable aseptic results. It would, I think, be easy to prove this from the constant soaking of saliva and other matters, in which this wound differs from others, but no better proof can be given than the fact that a patient on whom Mr. Butlin himself made trial of this method died, on the eighth day, of septic pneumonia.

(iv.) **The Écraseur.**—This may be used in different ways; the two following are the chief ones:

* The first of these was a Jew, prematurely aged, with epithelioma supervening on syphilis, who died, on the eighth day, of broncho-pneumonia. I fear that this was septic, though my colleague, Dr. Mahomed, who saw the patient during life, and who made the post-mortem examination, being influenced, chiefly, by the sweet condition of the mouth, was of a different opinion. In the second case, that of an itinerant musician over fifty, much broken down by poverty, exposure, and drink, I had removed the tongue far back for extensive epithelioma. The patient was left in bed, with orders that he should be carefully watched. For some reason these were not carried out. On my return in an hour's time I found him with his mouth full of clot, and a porringer half filled with bright blood. This was oozing from a vessel in the floor of the mouth close to the left alveolar arch. As the patient was most unruly, I had ether given for a few minutes, while the vessel was secured. No further bleeding took place, but the patient never "came to" properly, dying about sixteen hours later. His lungs were the seat of old broncho-pneumonia, and his kidneys showed advanced fibroid change, but the additional shock of the hæmorrhage and some blood in his lungs were undoubtedly, the cause of his death. Broncho-pneumonia carried off the third.

1. Through the mouth, in combination with scissors, a method used by Mr. Baker.*

2. By means of a puncture in the sub-maxillary region, or through a wound which has to be made here in the removal of enlarged glands.

The first of these only will be described here, as if the *écraseur* has to be made use of, it is by far the simplest and speediest method of using it.

In addition to the instruments already given in the description of the operation with scissors, the surgeon must be provided with a stout, short *écraseur*, curved on the flat, working smoothly and carrying a strong loop of whipcord, not of wire.†

The first part of the operation resembles that given at page 366. The tongue being well drawn out with a silk loop, the anterior pillar and the mucous membrane between the alveolar margin and the tongue being cut through, the tongue is then split with a bistoury along the raphé as far back as is needful, and its attachments to the floor of the mouth, partly snipped through with scissors, partly torn through with the finger. The tongue being now freed sufficiently to make the transverse divisions, two slightly curved needles, in handles, are made to perforate the tongue a full inch behind the posterior limit of the disease, and the loop is then slipped on and adjusted behind the needles. Before doing this, I would strongly recommend that a groove be cut with the scissors through the mucous membrane of the dorsum and sides of the tongue (p. 367); this simple step will serve to steady the bite of the *écraseur* and lessen the risk of its gradually coming, as it is tightened up, dangerously near the growth, and it will also shorten the time that the loop takes to effect its work. When first adjusted, the *écraseur* may be worked more quickly, but as soon as real resistance is felt the screw must be turned more slowly, a half or three-quarter turn being made every minute, or at longer intervals if the loop seems to be cutting too quickly. To avoid bleeding and snapping of the wire the tightening of the loop when once buried must be very deliberate (Hutchinson), the operation taking from half-an-hour to an hour.

* *Lancet*, April 10, 1880; *Dict. of Surg.*, vol. ii. Mr. Hutchinson (*Brit. Med. Journ.*, vol. ii. p. 1247) is a very strong advocate of the wire *écraseur*. His success, it must be remembered, is largely explained by the facts that a large number of his cases have been partial excisions, and many of them operations on private patients. It is well known how strongly Mr. Hutchinson has advocated early operations.

† Mr. Butlin (*Dis. of the Tongue*, p. 334) gives the following case: The only instance of death from hæmorrhage "in my table occurred in the case of a man whose tongue was removed with a strong wire *écraseur*, which cut through the tissue of the tongue like a knife, much more quickly and cleanly than had been intended. There was some smart hæmorrhage at the time, and it was not easy to get the man out of the operating theatre alive. The artery was not thoroughly secured, the bleeding recurred, and the patient sank and died a few hours later."

If oozing takes place from hurried use of the *écraseur*, it will be far more difficult to arrest on a surface bruised by this instrument than on one clean cut by scissors.

When the whole tongue is removed, the *écraseur* should always be applied to each half separately. Making the transverse section across the whole tongue at once is most tedious, and the great strain is likely to be too much for the loop or instrument itself. It also causes the constricted tongue to swell into a large livid mass, which much obstructs the breathing; and if, as is likely, both the linguals, which are left to the last, are divided simultaneously, the furious spiriting of these vessels in two crossing streams is most embarrassing.

I do not recommend the use of the *écraseur* for these reasons:

1. However well behind the disease the loop is placed at first (a step by no means easy to secure where the disease is situated far back), as it is slowly tightened up it tends to come forward (even when a groove has been cut in the mucous membrane), gradually grinding the needles placed to keep it in position and the loop closer and closer upon the diseased area, or, if not actually into this, into one from its close contiguity ready to take on disease.

2. I have seen, again and again, however carefully the tightening of the loop has been managed, that this is, finally, not fine enough to divide the lingual artery, which is dragged out in the eye of the loop, and has, after all, to be secured by ligature or torsion, often not without previous furious bleeding.

The galvanic *écraseur* has not been described. I mention it here only to condemn it. During the operation the loop may break, or it may cut its way too rapidly through the softened tissues, especially if the heat used is too great. Later on, the patient has still to run the gauntlet of the risks of septic lung trouble and secondary hæmorrhage which the use of this treacherous instrument entails.

After-treatment.—The chief objects here are: (1) To keep the wound sweet; (2) to give sufficient food.

The treatment I have made use of is as follows: For some days before the operation I make the patient practise* frequently washing out his mouth with Condyl's fluid, sitting up, and with the head alternately dependent to either side. He also gets used to feeding himself with a drainage-tube attached to a feeder-spout and passed by himself to the back of his throat.†

After the operation, the cut surface is brushed over with a solution of zinc chloride, gr. x— $\overline{3}$ j, or iodoform in ether; of the two, I prefer the latter at this time. Morphia is given as freely as is safe, with ice to suck, and, if the patient's condition is low, milk and brandy are administered either by a soft œsophageal tube

* This gives him something to occupy his mind, and cleanses the mouth.

† If the patient is at all intelligent, he will do this for himself far more painlessly than an assistant can.

or by enemata, or both. But I have generally found that, after the first six hours, a patient previously practised in the matter will give himself sufficient food.*

After the patient has had his first sleep, the surface is brushed over, every two or three hours at first, with iodoform and ether, and the patient is soon encouraged to sit up and wash out his mouth constantly with carbolic acid, 1 in 60 or 80, while from time to time the stump is painted over with ether and iodoform, a solution of creolin, or the following wash, a saturated solution of iodoform in ether with one volume in ten of turpentine added (Whitehead), or a wash of a tablespoonful of spirit of wine in a tumbler of water (Hutchinson). He should be kept warm and free from draughts, and either propped up or turned on to either side. I try to induce my patients to sit up a little on the second day if possible, and get them, when this is feasible, into an armchair a day or two later. Yolks of eggs, arrowroot, soups, pulped vegetables in broths, and such like are soon added to the milk and brandy, and beef tea.

Causes of Failure.

(1) Broncho-pneumonia. Pneumonia. Abscess and gangrene of the lungs. These must be placed first on account of their frequency. Septic in their nature, and due to the patient breathing foul gases, and drawing down putrid fluids into his lungs, the treatment must be preventive, every endeavour being made to keep the mouth sweet, and to relieve the patient's breathing by attention to the details already given.

(2) Hæmorrhage. This is rarely met with at the time of the operation or soon after, if every spirting artery has been properly secured. It will also be rarely met with as a secondary complication if the wound has been kept sweet. In cases of bleeding, if the application of a silk ligature to the bleeding point taken up by a Spencer Well's forceps or a tenaculum is impossible, firm pressure with a sponge on a holder should be made use of after all clots have been removed. If the wound has been allowed to become foul, it must be cleansed by brushing it over with iodoform and ether, or with turpentine—a most powerfully cleansing styptic,† and one always to be used in preference to perchloride of iron. If all the above fail, either applying and leaving *in situ* a pair of Spencer Wells' forceps, packed around with soft gauze, or ligature of the lingual, must be resorted to (p. 470).

(3) Cellulitis. Erysipelas. (4) Pyæmia. (5) Exhaustion—more rarely, shock. (6) Œdema of the glottis. (7) Suffocation from falling back of the tongue. (8) Recurrence. I have spoken fully of the gravity of this complication at p. 361. For the first year after the operation every patient should come under skilled supervision at intervals of a month and no more.

* If this is not the case, a soft tube must be passed.

† See the remarks at p. 469. If the bleeding is of the nature of oozing, one or two injections of ergotin should certainly be tried.

CHAPTER XI.

OPERATIONS ON THE TONSIL.

REMOVAL OF NEW GROWTHS OF THE TONSIL.

THE new growths here are most commonly round-celled sarcomata and epitheliomata.

In sarcomata there is steady enlargement of one tonsil in an adult, without pain at first or inflammation, a globular swelling, the size of a walnut, appearing firmly elastic, tending to infiltrate adjacent structures, and fungate as a sloughing mass into the mouth.

In the epitheliomata, the patients are older: the mischief often begins "as a sore throat." The mass occupying the site of the tonsil is now much harder and soon ulcerates, forming an excavated ulcer with the characters of epithelioma. The base of the tongue may be involved secondarily. Dysphagia, emaciation, &c., are more rapid here.

Before describing any operations for removal of tonsillar growths, it is right to allude to their great malignancy, owing to the rapidity with which the glands are affected. In this, rather than in the importance of its relations, lies the failure of operations on the tonsil, and no one who has watched the rapidity with which enlargement of the glands at the angle of the jaw takes place in subacute tonsillitis will wonder at this.

Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 174), writes on this point: "So early in the course of the disease are the glands affected that they may appear as large swellings in the neck within a few weeks of the period at which the first signs of the disease were noticed by the patient. On the other hand, there may be no visible or tangible glandular enlargement until six or more months have elapsed from the first occurrence of enlargement of the tonsil. The disease proves fatal, in very many instances, within a year, or even six months of its first appearance; indeed, few persons survive for more than three-quarters of a year."

Dr. Newman (*Mal. Dis. of the Throat and Nose*, p. 176) draws a distinction here which may be of practical importance. While admitting that round-cell sarcomata quickly invade the glands, he points out that the spindle-celled sarcomata may remain imbedded within a capsule, and so be capable of complete removal.

Thus, in one case of Dr. Newman's the patient lived five years after removal of a spindle-celled sarcomata through the mouth, and then died rapidly owing to disease appearing in the opposite tonsil.

Operations.

A. Through the Mouth.

B. By Incision in the Neck.

Whichever method is chosen, the selection of cases here for operation must be a very careful one, owing to the great malignancy of these growths, and the advanced stage which the disease has often reached.

Cases favourable for operation. Where the growth is still small, hard, localised to the touch, well defined, still movable, free from ulceration, and where no enlarged glands can be made out. On the other hand, where the swelling in the mouth is continuous with one in the neck, each diffuse and ill-localised, and the primary growth showing a friable, sloughy, ulcerated surface, operation will be probably contra-indicated. In intermediate and doubtful cases, as where one or more enlarged glands exist, but still separate and mobile, the surgeon will be quite justified in giving his patient a chance, knowing the distressing future if the growth be left, the agonising earache, the dribbling of fetid saliva, the dysphagia, &c.

A. Through the Mouth.—This method can only be made use of (*a*) in a very early stage of tonsillar new growths, when there is no evidence of glandular enlargement; or (*b*) when epithelioma of the tonsil co-exists with a similar condition of the tongue.

If the following operation seems somewhat severe, the infiltrating tendency of growths here must be remembered.

In most cases the surgeon will do well to avail himself of the help given by the following preliminary steps: (1) Laryngotomy and plugging the fauces with a sponge (p. 384), placing a temporary loop round the common carotid (pp. 485, 492); (2) slitting the cheek.

The patient's head being suitably raised and supported, in a good light, the cheek on the affected side is divided from the angle of the mouth to the masseter, and the two ends of the facial artery tied or twisted. The mouth is now kept widely open by a gag inserted on the opposite side, the tongue drawn out of the mouth, and the masseter pulled backwards by a retractor. As much room and light as possible being thus obtained, the surgeon divides the soft palate first in the middle line, and then from within outwards with scissors; he next, either with the same instrument or with a blunt dissector and his nail, dissects around and carefully enucleates the tonsil with the pillars. The whole operation should be deliberately carried out, the surgeon cutting wide of the growth and encroaching on the tongue, &c., if needful. Bleeding will be best arrested by temporary forci-pressure, and firm sponge-pressure.

Where the growth is at all cauliflower-like in its prominence,

the chief part may be first removed with a heated wire or with the Paquelin's cautery, so as to get more room in dealing with the base. And if the surgeon so prefer he may do the whole operation with the cautery instead of the scissors. In any case the cautery must be used at a dull red heat only for fear of hæmorrhage. The surgeon must be prepared for its leaving indurated tissues which may simulate deposits of growth, and for the tendency of the instrument, as it is quickly cooled down by its contact with succulent tissues, to stick to them. A little additional heat frees it at once, far more satisfactorily than pulling it away. I prefer to limit the cautery, if used, to searing thoroughly the surface of the wound.

Mr. Butlin points out that some of the new growths met with here are so easily separable, so circumscribed, if not encapsuled, that there is not the least difficulty in shelling them out.*

The after-treatment will be similar to that given (p. 375). The laryngotomy-tube may usually be removed as soon as the operation is over.

B. By Incision through the Neck.

(1) *Cheevers' Method.*

Where enlarged glands exist, or where the surgeon is anxious to define and draw aside the important structures which lie outside the tonsil, this method will be employed, either alone or in conjunction with one inside the mouth.

The following account of the above method, somewhat modified, is taken from a case of Mr. Golding Bird's:†

An oblique incision was made from the lobule of the left ear, downwards and forwards, to the hyoid bone. The superficial structures and deep fascia were divided, a branch of the external jugular vein alone requiring ligation.

An enlarged lymphatic gland was shelled out and the digastric exposed. This and the stylo-hyoid were then divided, and a second hard gland being found, it was also removed; it lay against the internal jugular vein. On retracting the posterior border of the wound and pulling forwards the angle of the jaw, the stylo-glossus and stylo-pharyngeus were seen and divided, fibre by fibre, on a director. Neither the hypoglossal nerve nor the glosso-pharyngeal was observed. The fascia investing the posterior part of the sub-maxillary gland was now slit up, and the facial artery ligatured and divided. The internal jugular vein was now fully exposed for more than 1 inch. The internal carotid was not seen, but covered with fascia, was felt pulsating. These two vessels being drawn outwards by a retractor, the wall of the pharynx was, by tearing through some yellow fat, fully exposed, bulging to and fro with the respiration. No vessel save the two already named required securing; and at the upper part of the wound was what appeared to be the pes anserinus. A second incision was now made through the cheek from the angle of the mouth ‡ towards that of the jaw. There was no

* *Loc supra cit.*, p. 175. Mr. Butlin allows that, unfortunately, recurrence is not less probable after shelling out. I prefer the method of removing widely.

† *Clin. Soc. Trans.*, vol. xvi. p. 9. The case was one of epithelioma, in a patient aged forty-five.

‡ In Cheevers' method the second incision is made along the horizontal ramus of the lower jaw. If this is made use of, it is made at the beginning of the operation, and the flap thus marked out thrown down. This would give more

hæmorrhage, as the facial artery had already been secured. With the left fore-finger in the mouth and the right in the wound, the enlarged tonsil could easily be moved between them, and it was removed, together with the adjacent piece of the pharyngeal wall, by the electric cautery, employing this partly as a knife and partly as an *écraseur*.*

The patient made a very good recovery, air ceasing to pass through the wound in the neck on the sixteenth day.

In spite, however, of the thoroughness of the operation the disease recurred in the glands within six weeks, and within two months it returned in the throat as well.

The following remarks of Mr. Golding Bird deserve careful consideration. Admitting the feasibility of the operation, he says: "The question of expediency, however, demands the fullest attention; and I am inclined to think that the plan adopted in my second case referred to—namely, feeding by a soft œsophagus-tube, with the alternative eventually of performing gastrostomy—more likely to meet all the real requirements of these cases, unless seen so early that there can be no suspicion of the growth having extended beyond the tonsil, nor of having invaded the lymphatic system except to a very limited and remediable extent."

The account of the next two operations is taken from Mr. Butlin (*loc. supra cit.*, pp. 176, 177).

(2) *Czerny's Method.*

A preliminary tracheotomy having been performed, and the larynx or fauces plugged, an incision is made downwards and outwards from the angle of the mouth to the anterior border of the masseter, and beyond it to the level of the hyoid bone. Through this incision the lower jaw is exposed and sawn through, between the second and third molars, from above downwards and outwards, and the two fragments are held asunder. The growth is by this means laid bare, and to remove it it may be necessary to divide the digastric, stylo-hyoid, and stylo-glossus muscles and the hypo-glossal, glosso-pharyngeal, and gustatory nerves, as well as the lingual and other vessels. The growth is then cut or torn out, and the bleeding points are touched with the cautery. The wound is thoroughly washed out with carbolic lotion, or dusted with iodoform, the fragments of the lower jaw wired, a second wire twisted round the adjacent molars, and the external wound closed with sutures, except at points for the exit of drainage-tubes.

(3) *Mickulitz' Method.*

This is intended to be even more radical than that of Czerny.

room for the subsequent dissection (especially in a stout patient), and would be more likely to expose enlarged glands. The incision through the cheek might be made as well, later on, as in Mr. Golding Bird's case.

* Mr. Golding Bird, in his remarks on this case, stated that in another case he should open the pharynx with scissors, owing to the difficulty which the use of the cautery creates in knowing whether the required depth has been reached in the extirpation of the growth.

An incision being made from the mastoid process downwards and forwards as far as the great cornu of the hyoid, the soft parts are raised from the jaw, the facial nerve being preserved if possible, and the periosteum is separated from the outer and inner aspects of the jaw, just above the angle. The jaw is then sawn through beneath the periosteum, the tendon of the temporal divided, and the greater part of the ascending ramus resected. After drawing aside, with strong hooks, the body of the jaw, the masseter, internal pterygoid, digastric, and stylo-hyoid, Mickulitz found that the surface of his wound corresponded as nearly as possible with the region of the tonsil, and, by dividing the lateral wall of the pharynx, he obtained access to the palate, the base of the tongue, and the posterior wall of the pharynx as far up as the nasopharynx; and by dividing the digastric muscle and the hypoglossal nerve, he could reach the entrance of the larynx. Mickulitz prefers to do a preliminary tracheotomy, and claims for his operation, not only ease in reaching and removing the disease, and in dealing with lymphatic glands, but, further, that the whole wound communicates freely with the outside, and can be dressed antiseptically. So far from the resection of the ascending process being a disadvantage, it offers the positive advantage of giving more mobility of the jaw than is otherwise present after the contraction of the scar which takes place after any of these operations.

Mickulitz's patient was a woman, aged sixty-five, and the disease had existed about four months. She recovered, and remained well for two years, when recurrence appeared in the glands.

Choice of Operation.—I have spoken above of the need of a very careful selection of cases. Wherever it is possible the intra-oral method should be employed. The fact that this and other methods have given disappointing results is due to the operation being still too long deferred. The several methods in which the growth is attacked through the neck have not given superior results to that obtained by Dr. Newman in his case quoted at p. 378, and which survived an operation through the mouth for five years. This excellent result was due to the operation being performed before the glands became affected.

CHAPTER XII.

OPERATIONS ON THE AIR PASSAGES IN THE NECK.

THYROTOMY—LARYNGOTOMY—TRACHEOTOMY— REMOVAL OF FOREIGN BODIES IN THE BRONCHI— EXCISION OF THE LARYNX.

THYROTOMY.

Indications.

(i.) Growths which cannot be removed through the mouth, but which do not require severer operations on the larynx itself. The following are the chief conditions which must decide the removal of laryngeal growths by an operation from the mouth or by thyrotomy:

(a) The amount of special laryngeal skill possessed by the operator. (b) The nature of the growth, whether multiple or no, if pedunculated, if recurrent after attempts at removal from the mouth. (c) The extent of the growth. (d) The irritability of the larynx. The amount of self-control of the patient. Any tendency to asphyxia.

(ii.) Large rough foreign bodies*—*e.g.*, bits of bone, &c.

In a case brought before the Clinical Society † by Dr. Taylor and Mr. Golding Bird a bit of mutton-bone was impacted between the vocal cords, where it could be seen with the laryngoscope. It was removed by Mr. Golding Bird by a vertical incision with its centre over the cricoid cartilage, the crico-thyroid membrane being incised horizontally. A tracheal dilator being introduced, the bone was seen at once, and extracted with Toynbee's ear-forceps. The large size of the fragment, its apparently firm position, the fact that the broad surface, and not the edge, presented, together with its position just at the crico-thyroid membrane led to the external operation being made use of.

Operation.—A preliminary laryngotomy (p. 384), or a high tracheotomy, according to the amount of room required, having been performed, the incision is prolonged upwards, and the skin

* Mr. Holmes (*Med. Chir. Trans.*, 1882) has drawn attention to the fact that large substances may be impacted in the ventricle or between the alæ of the thyroid cartilage without causing any symptoms of immediate urgency. As they are liable to give rise to spreading inflammation of the mucous membrane, they should be removed as soon as possible.

† *Trans.*, vol. xvii. p. 214.

and fasciæ over the centre of the thyroid cartilage are carefully divided. All hæmorrhage is then arrested, and the cartilage opened along its centre with scrupulous exactness, the thyro-hyoid and crico-thyroid membranes being also divided if needful. The halves being now held widely open, the foreign body is picked out or the papillomata removed.

During the above operation, it may be well to remember the following points. If much hæmorrhage is expected, as in the case of some papillomata (if large or recurrent), it would be well to plug the air passage below, by the side of, and around the tube which has been inserted, either by a sponge attached to silk or by putting the tube into a collar of drainage-tube of sufficient thickness. The division of the thyroid cartilage should be effected from without inwards, a stout knife, bone-forceps, or even a saw being sometimes needed in adults. As soon as the upper part is divided, the surgeon should examine if he has sufficient room without further division, and if it is really needful to cut down lower, the meeting of the cords must be treated with the utmost delicacy, and, if the parts have to be opened out, as little tension and stretching as possible should be thrown upon this spot.*

The removal of papillomata is often attended with much difficulty owing to their friability.† They are best snipped away with scissors curved on the flat, and their bases touched with some powerful astringent—*e.g.*, acid nitrate of mercury, or, as I prefer, the actual cautery, owing to their tendency to recurrence, often inveterate.

The object of the operation being accomplished, and all hæmorrhage arrested, the alæ of the thyroid are united by one or two points of silver suture not passed through the entire thickness of the cartilage. A little iodoform is dusted on, and lint out of boracic acid (warm or cold, according to the feelings of the patient) is kept constantly applied.

The tracheotomy-tube must not be removed till all risk of intra-aryngeal oedema, &c., has passed by, though it may be early replaced by one of india-rubber. The after-treatment and complications are much as after tracheotomy (p. 392). Coughing will be especially harmful now.

* Mr. Parker (*Dict. of Surg.*, vol. ii. p. 623), advising that, if it is needful to cut the anterior commissure of the cords, the two alæ of the thyroid should not be quite severed, points out that, in children, the parts being elastic, retraction will accomplish much, but that in old people, or where the growth is large or extensive, not only all the cartilage and the thyro-hyoid membrane must be divided, but that, to secure still more room, horizontal incisions may be needed through the crico-thyroid and the thyro-hyoid membranes, close to the borders of the cartilages.

† Mr. Parker (*loc. supra cit.*) found in one case much difficulty in seizing the growths, owing to the reflex excitability set up, notwithstanding deep narcosis. He thinks that the use of cocaine will here be a material aid. I have found this of much practical value in one case.

Impairment of the voice is not unlikely to occur after thyrotomy, quite apart from any injury inflicted on the cords during the operation, owing to the cicatrix subsequently involving the anterior commissure of the cords. Other possible causes, in spite of aseptic precautions and gentle handling, are chronic laryngitis, the formation of granulations, impaired movement of the thyroid, or displacement of the cords. Where the masses of papillomata are large, though the removal has been complete, the patient may never be able to dispense with his tube.

LARYNGOTOMY.

In this operation the tube is inserted through an opening in the crico-thyroid membrane. It is called for, in preference to tracheotomy, on account of the greater facility with which it is performed, in cases of emergency, and in those where a tube can quickly be dispensed with.* Finally, it is inapplicable before adolescence.

Indications.

1. Sudden impaction of large foreign bodies threatening suffocation, as when a bolus of food carelessly swallowed lodges in the upper aperture of the larynx.†

2. Before operations likely to be attended with much bleeding—*e.g.*, those on the tongue, jaws, tonsils, &c.—in order that the fauces may be plugged with a sponge.

3. When spasm of the larynx is threatening very suddenly, as in tetanus or aortic aneurism.‡ As a rule, tracheotomy, when there is time to perform it, is preferred in these spasmodic affections, and it will be considered later (p. 401).

Operation.—An anæsthetic will be given in those cases in which laryngotomy precedes another operation; in other cases the patient's head must be kept steady. In either instance the head will be thrown back as far as possible, while the neck rests on a firm support. The precise position of the thyroid and cricoid cartilages is then distinctly made out, the notch in the upper part of the former and the ring of the latter being almost always recognisable. The larynx being then steadied (not squeezed) with the left fingers and thumb, and the skin at the same time made moderately tense, an incision about 1½ inch long is made, exactly in the middle line, over the lower part of the thyroid, the crico-thyroid interval, and the cricoid.

If relief is urgently called for, the knife should pass down to

* Owing to the proximity of the tube to the cords, this operation is not suited to cases in which an instrument has to be worn for any time.

† In these very urgent cases the operation may be performed with, *faute de mieux*, a sharp penknife and a toothpick quill.

‡ Sir J. E. Erichsen, in his *Surgery*, gives many other conditions for which a high tracheotomy is usually reserved.

the crico-thyroid membrane at once, and the left index having identified this, the membrane is opened by cutting horizontally just above the cricoid cartilage.

If the surgeon have more leisure, he may reach the crico-thyroid membrane more gradually, feeling his way, using retractors, and perhaps identifying the interval between the sterno-hyoids and the crico-thyroids. The only advantage of this is that all hæmorrhage can be arrested before opening the air-tube.

In inserting the tube, care must be taken that both the crico-thyroid membrane and the subjacent mucous membrane are punctured, and that the tube is really within the cavity of the larynx, not pushed down into the cellular tissue outside it. The cannula, which should be shorter than those used for tracheotomy, of uniform bore throughout, and oval in section, is then secured with tapes.

TRACHEOTOMY.

This operation will be carefully considered under the first of the following indications, and more briefly in its relation to the other ones.

Indications :

1. Croup and diphtheria.
2. Syphilitic and tubercular ulceration, in order to give rest to the crippled part (p. 401).
3. Malignant disease of the larynx (p. 401).
4. Acute laryngitis.
5. Certain spasmodic affections, *e.g.*, tetanus, or aneurism of the thoracic aorta (p. 401).
6. Foreign bodies in the air passages: the removal of those which may lodge in the bronchi are treated separately (p. 403).

TRACHEOTOMY FOR MEMBRANOUS LARYNGITIS.*

General points all bearing upon a successful result: †—(A) The age of the patient. (B) Right time of operating and wise selection of cases. (C) Skilful operation. (D) Painstaking and appropriate after-treatment.

A. **Age.**—Recovery before the age of two is very rare. Some of the youngest cases recorded are Mr. Bell's at seven months, and Mr. Cooper Forster's at eleven months.‡ On the other hand,

* Under this head are included the two diseases whose identity has been disputed—croup and diphtheria.

† If a little amplified, the conditions chiefly affecting success would run somewhat thus:—1. How far has the operator picked his cases? 2. What proportion was diphtheritic? 3. How many were very young? 4. Was the operation an early or a late one? 5. Was the operator experienced? 6. Was the after-treatment skilful?

‡ M. Bazeau (*Gaz. des Hôp.*, 1867, p. 397) mentions successful cases of tracheotomy in infants of ten and fifteen months. The very youngest cases with which I am acquainted are one in which Mr. Croft operated successfully in an infant, aged six months, with erysipelatous œdema of the neck and chest, and another, still younger, which is quoted in the *Med. Times and Gaz.*, 1880, vol. ii. p. 593.

M. Trousseau considers that the frequency with which tracheotomy is unsuccessful in adults with membranous laryngitis is due to the fact that the large size of the larynx retards asphyxia till the bronchi are invaded. Again, the older children are, the more strength have they, and the better the hope of recovery; whereas younger children fail more quickly with their poorer vitality, and the greater facility with which their narrow air passages are choked up with membrane, &c.

*Average of Recoveries after Tracheotomy for Membranous Laryngitis.**—One case in three or four is a good average. Prof. Buchanan† cured nineteen out of fifty, or one in every $2\frac{2}{3}$ cases.

B. Right Time for Operating,‡ and Wise Selection of Cases.—The nature of the dyspnœa is very various, and on this account the above two points are most important.

The four following conditions of dyspnœa are met with: (i) Dyspnœa rapid, urgent, and localised to the larynx; much anxiety and restlessness; orthopnœa; stridor, the loudness of which is probably proportionate to the degree of obstruction in the larynx and the patency of the small tubes. In Prof. Buchanan's words, it points to a cavity ready to receive air if it could but get it, and to a passage narrowed either by false membrane or spasm, or both. On inspection of the chest, the extraordinary muscles of respiration are seen to be in action, there is much sucking-in of the infra-costal and epigastric, and, later on, of the supra-sternal and supra-clavicular regions. While this sucking-in is vigorous and well marked, the lungs are probably free. Auscultation and percussion are difficult. If the bases are

* Turning to the results of foreign surgeons, Dr. Lindner (*Deut. Zeitsch. f. Chir.*, Bd. xvii. Heft 6) states that after the second year there was a marked improvement. In this year the recoveries amounted to 12 per cent., in the third year they rose to 55 per cent. Dr. Passavant, of Frankfort-on-Maine (*Annals of Surgery*, vol. i. p. 582) gives 67 cases of cure out of 229, or about 1 in 4.

† *Trans. Intern. Med. Congr.*, 1881, vol. iv. p. 208.

‡ Those surgeons who recommend an early operation, and I am of that number, rely especially on the existence of much sucking-in and of undoubted dyspnœa. With regard to the first, Dr. Passavant (*loc. supra cit.*, p. 153) holds that tracheotomy, if deferred, allows prolonged dyspnœa to bring about, simultaneously with retraction of the epigastrium, &c., an action on the lung-surfaces analogous to that of a cupping-glass upon the skin—viz., hyperæmia, stasis, hyper-secretion of mucus, splenisation, and atelectasis. With regard to dyspnœa. Dr. Ranke, of Munich, lays great stress upon an early operation: "If a child with pharyngeal diphtheria has become hoarse, and shows laryngeal stridor and difficulty in breathing, which has already led to ever so short an attack of real dyspnœa, that child ought to be operated upon at once." Another practical point bearing upon the right time for operation is the fact that at night-time children often get worse. If, then, a case is advancing, and parents cannot towards the day's close make up their minds to sanction an operation, they may be warned that the patient's condition may call for an operation which will be of necessity hurried, and performed under much less favourable circumstances as to light, &c.

resonant, and show vesicular murmur, it is of good omen. So, too, if the eyes, though starting, are bright, the face suffused, not livid, the lips of fairly natural colour, the cervical veins not much distended, the extremities not cold and the seat of stasis. In such cases the membrane, if present, is limited to the larynx, and the tendency to death is by laryngeal apnoea. Tracheotomy here is not only justifiable, but imperatively called for, if previous treatment has failed; the prognosis is favourable if the operation is not too long deferred. Hopeful conditions: Sudden onset, previous good health, sub-maxillary glands not enlarged, absence of albuminuria.

(ii) When the dyspnoea increases more slowly though continuously. The restlessness is less violent, and the respiratory effects less exaggerated. The sucking-in is much less marked, especially above. The chest seems to be impeded in its movements, puffing or heaving out *en masse*, and with difficulty; on auscultation and percussion, instead of vesicular murmurs, or conducted hoarse laryngeal rhonchus, and normal bases, will be found sibilant râles, small crepitation, and deficient resonance. These point to the exudation being no longer localised to the larynx, but more probably invading the finer bronchial tubes and air-vesicles, the former being swollen and infiltrated with membrane, the latter clogged with viscid mucus. The tint of the face is now pale or leaden. The operation is here much less likely to be successful, from the extension of the membrane, and the condition of the lung and of the right heart. Other unfavourable conditions: Onset with much asthenia, albuminuria, and enlarged sub-maxillary glands.

(iii and iv) Dyspnoea intermittent or paroxysmal. In the former case it is due probably to collections of viscid mucus or membrane in the larynx and trachea. Good power of expectoration is here very important. Paroxysmal dyspnoea means spasm. This, very common in all laryngeal dyspnoea, is especially so in children. The danger of this is obvious, and the question of tracheotomy will have to be decided according to whether the spasms are increasing, and by the distance of the medical man from his patient.

Three chief dangers of deferring the operation too long.

(1) Œdema of the lungs.* Owing to the deficient entrance of air, reflex contraction of the pulmonary arterioles takes place, leading to distension of the main trunk, the right heart, and systemic veins. The bronchial veins being also engorged, serous exudation takes place into the finer tubes and vesicles at the bases, and respiration is thus further impeded.

(2) Exhaustion of the heart. Children if they repair quickly are exhausted quickly also.†

* See also the note, p. 386.

† Prof. Buchanan (*loc. supra cit.*, p. 208) makes an important distinction

(3) Thrombosis of the pulmonary artery. Owing to the stagnation in front, the blood current moves more and more slowly, and this obstruction by thrombi is not remediable by operation. The signs of this condition are, increasing dyspnœa, very feeble pulse, and combined pallor and lividity.

Recommendation of the operation to the friends.—(a) In reply to questions as to the chance of cure, the surgeon will answer, with caution, that the operation conduces to cure by removing the most urgent danger, by giving relief to the lungs, and thus also improving the strength by sleep and quiet. (β) He will be able to say that if death occur after tracheotomy it will be by exhaustion, not by apnœa most distressing to witnesses as well as to the patient.

Operation.

Question of Anæsthetic.—A little* chloroform is, as a rule, safe and advantageous. It allays spasm and thus improves the breathing. It prevents struggles and promotes sleep afterwards. Any vomiting afterwards will probably be beneficial. It is especially useful in recent and vigorous cases, where the surgeon is very short of assistance, and where, if I may say so, his practical experience of the operation is not large. Under the opposite conditions it is not needed; and it will, of course, not be given where there is any tendency to cyanosis and unconsciousness.

Site of Operation.—High or low, *i.e.*, above or below the isthmus. It will be worth while just to consider here the parts met within the middle line, (A) above, and (B) below, the thyroid isthmus. (A) Skin, superficial fascia, branches of transverse cervical and infra-maxillary (7th) nerves, lymphatics, cutaneous arteries, anterior jugular veins—which, with their transverse branches are smaller here—deep fascia, cellular tissue, superior thyroid vessels, the isthmus, usually over the second and third rings,† and tracheal layer of deep fascia. The importance of this last is twofold: if the trachea be insufficiently opened the tube may be passed between the trachea and the fascia overlying it, embarrassing the breathing and the operator alike. If the wound become unhealthy, this layer, continuous below with the pericardium, may conduct pus into the mediastina. (B) The surface-structures are much the same, but the anterior jugular vein and its transverse branches are much larger. The sterno-thyroids are here‡ quite close together. The inferior thyroid

between sthenic and asthenic cases. In the latter, where the vital powers are rapidly failing, tracheotomy will not save the patient, and scarcely, if at all, mitigates the suffering.

* Just enough to prevent struggling during the operation. After the skin is incised, less is needed.

† Mr. Parker (*Tracheotomy*, p. 37) says that in children the isthmus is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring.

‡ Above, the sterno-hyoids are almost in contact in the middle line, with only an interval of about $\frac{1}{8}$ inch, a strong argument in favour of keeping in the middle line exactly (Parker).

veins are larger. A thyroidea ima may be present, and the innominate artery cross as high as the seventh ring. The trachea is also deeper, smaller and more mobile, having no steadying muscles here as higher up. The thymus, too, in young children, might present a difficulty. In addition to the above anatomical objections to the low operation, there are three surgical ones—viz., (1) Pus is now more easily conducted into the mediastina. (2) In the same way broncho-pneumonia is more probable from a wound in the trachea lower down. (3) From the proximity of the chest, and its suction-action, the tube is much more pulled into the wound, and if it has to be worn for a long time, the tube and shield may part company (Mr. J. Wood, *Lancet*, 1872, vol. i. p. 317).

Operation.—The instruments required are—a small scalpel, with a triangular-pointed handle to act as a blunt dissector, two pairs of Spencer-Wells' forceps, dissecting-forceps, steel director, silk or chromic gut ligatures, one or two wire sutures, pilot, and tube.* They should be spread out ready to hand, as, in an instant, moving the child, or beginning the anæsthetic may cause most urgent dyspnœa. The question of the anæsthetic has already been alluded to (p. 388). The child's neck and head, at first raised and relaxed,† are stretched over a sandbag or a large bottle wrapped up in a towel, while the hands are secured in the jacket which firmly encircles the body. Two assistants are desirable, one to support the head and give the anæsthetic, the other to sponge. It is almost superfluous to add that the light should be the best possible, a laryngeal mirror may be of much use in

* The best tracheotomy tubes are those of Mr. Durham, Mr. Bryant, and Mr. Parker. If the first are chosen, they must be of reliable manufacture. The ball-and-socket of Mr. Bryant's tubes allows of free play. Mr. Parker (*loc. supra cit.*, p. 84) argues strongly in favour of angular tubes. He shows that the usual $\frac{1}{4}$ -inch tubes impinge with their lower extremity on the anterior wall of the trachea, thus tending to produce ulceration and grave risks (p. 397). Mr. Parker, I think, entirely proves his point. I have used his tubes, but find the absence of a pilot troublesome in dealing with little children.

Whatever tube is chosen, it should be as large and as short as possible; it should be of the same size throughout, without tapering; the inner tube should project a little beyond the outer one; while the whole tube should fit snugly, standing out as little as possible in the neck.

As to the size of the tubes needful, Mr. Parker recommends a series running from No. 18 to No. 30, French gauge, the most useful sizes for children being Nos. 18, 20, 22, 24, 26, and 28 for the outside tube. On this matter of the size of the tube and its relation to the aperture of the glottis and size of the air-tube, the reader should consult Mr. Holmes (*Dis. of Children*, p. 324), Mr. Howse (*Guy's Hosp. Reports*, 1875, p. 495), and Mr. Marsh (*St. Barthol. Hosp. Reports*, vol. iii.).

† Whenever an anæsthetic is being given in cases of dyspnœa, the patients, whatever the age, should be allowed to choose their own position at first, and any movements or alterations in the position of the head and neck, preparatory to the commencement of the operation, should be carefully made.

illuminating the bottom of the wound. The surgeon* with his left thumb and forefinger steadies the trachea, and makes it a little prominent as well, without any compression; he then incises the soft parts in the middle line from about the centre of the cricoid† downwards for about 2 inches, cutting well through the fat, often abundant here, and exposing the interval between the sterno-hyoids, he then incises this interval, and, if he has reason to fear hæmorrhage, with the point of a steel director‡ placed in the upper part of the wound, he slits down the remaining soft parts in the middle line till he can distinctly feel or, with the aid of retractors, see the tracheal rings.§ The point of the knife is often required here to incise surely the tracheal fascia. Until the tube is distinctly exposed the left forefinger and thumb must not be removed from their steadying position on either side. With the blade of the knife held upwards the middle line of the front of the trachea is then punctured, stabwise, and two or three rings divided. Sufficiency of the opening is known by a free and noisy rush of air, accompanied often by the expulsion of membrane, which should be sponged away at once. On the other hand, an inadequate opening will be indicated by the hissing only of air through the slit-like opening, without any free rush and with no escape of membrane or relief of the dyspnœa. In this latter case the first opening must be found by the finger-nail and carefully enlarged.|| The cannula is then inserted on a pilot and secured with tapes *in situ*. Some prefer to use a hook to steady the trachea, and a pair of dressing-forceps to dilate the opening; these are more likely to be helpful in a "low" operation, or where a pilot is not used to insert the cannula. If it be desired to try and remove any membrane,¶ the cannula should not be inserted

* He first, as soon as the head and neck are in position, marks the chief spots in the middle line—viz., centre of the chin and manubrium, and (when they can be felt) the hyoid bone and the thyroid and cricoid cartilages, especially the last.

† This cartilage is often incised, a point to be, however, avoided. The parts are so small in a child that a tube put in by incising the cricoid is likely to irritate the larynx. Of this the cricoid is the narrowest and a very rigid part. Only the smallest cannulæ can be used here.

‡ Mr. Whitehead (*Lancet*, April 30, 1887), having found that the sharp point of a director will tear open the thin-walled veins here, uses a raspator after the skin incision. With this he separates the sterno-hyoids, splits the fascia running from the hyoid to the thyroid isthmus, and then, pushing this split fascia on either side with the raspator, pulls down the isthmus and exposes the trachea. the whole operation being thus rendered easy and bloodless.

§ Dr. Buchanan considers the following a golden rule: "Never plunge the knife into the trachea till the white rings are clearly seen in the bottom of the wound." In cases of real urgency the surgeon must be satisfied with touch and not with sight.

|| If the opening be to one side, as well as too small, a fresh and adequate one should be made in the middle line.

¶ Mr. Parker, one of the chief authorities on this subject, strongly advises that all membrane as well as mucus be got rid of, on account of its impediment to

at once, but the opening dilated with dressing-forceps, or with Mr. Golding Bird's or Mr. Parker's dilator. When inserted, the cannula must lie in the middle line, otherwise there will be troublesome irritation of the trachea and plugging of the cannula.

Chief Difficulties.—(1) Insufficient skin incision giving no room for the deeper work.* (2) Not keeping to the middle line; the abundant fat, and the indistinctness of landmarks—*e.g.*, a flat thyroid in a little child aiding this mistake. (3) Not steadying the trachea. This omission leads to missing the tube altogether. Cutting to one side of it, or cutting into it laterally, instead of centrally, and insufficiently. (4) Hæmorrhage, the chief bugbear of the operation, varies extremely. Generally it is not great. Any artery which springs should of course be tied at once or caught in Spencer-Wells' forceps, and a vein of any size which lies in the way should be caught between two of these forceps before it is divided. Venous hæmorrhage, as a rule, stops as soon as the trachea is opened and respiration established. A sufficient median skin incision aids the meeting of hæmorrhage. With regard to the isthmus of the thyroid, this may usually be neglected by the surgeon; if felt by the finger to be large, it may be depressed.† If encountered in older subjects, or if large in children, it may be compressed by two pairs of Spencer-Wells' forceps before division, or ligatured on either side by passing an aneurism-needle beneath it. If, as rarely happens, the venous bleeding is very free, and the patient's condition from dyspnœa critical, the trachea must be felt for and opened before the hæmorrhage is arrested. The urgency of the case must here come before the amount of the bleeding. In these cases the moment the tube is opened the patient must be turned well over on to his side. Entrance of blood, to any amount, into the lungs must be avoided as not altogether harmless; it will add to the dyspnœa now, and, later on, may set up broncho-pneumonia. (5) Insertion of cannula. If the trachea has not been steadied, and the rings not clearly made out by sight or touch, the opening will very likely be made inadequate or to one side. Another difficulty may arise here from the tracheal fascia not having been sufficiently cut, or from the tube being pushed down between this fascia and the trachea, this, of course, only further embarrassing

respiration, its infectiousness, and the patient's inability to get rid of it himself by coughing after tracheotomy. On this account Mr. Parker recommends gently twirling about a feather (the shorter and finer pheasant-tail feathers are the best) soaked in solution of sodium carbonate, and passed several times, not only down into the trachea, but up into the glottis. Mr. Parker condemns attempts to suck out membrane by putting the lips directly to the wound, as of no service to the patient, and as possibly very disastrous to the operator. The aspirator he recommends is alluded to (p. 392).

* As in a colotomy, or any other deep incision, the wound should not be funnel-shaped.

† In children this may certainly be ignored. If the knife is used to open cleanly and sufficiently the deep fascia, and then a round-pointed steel director to clear the way down to the trachea, the operation will be almost bloodless.

the breathing. Lastly, though the tracheal rings are cut, the swollen and inflamed mucous membrane may not have been sufficiently divided, or a false membrane may have, in the same way, been carried before the knife. (6) Little or no relief after insertion of the cannula. Though this may have been well and truly done, it is not followed by the relief which has been expected. This may be due (*a*) to the tube being passed between the trachea and some membrane which plugs it; (*b*) to the trachea and bronchi being blocked with membrane, &c.; (*c*) to the child, owing to the operation being performed late, being practically asphyxiated before the completion of the operation. The indications now are to pass a long narrow feather down the tube, to remove the tube, and to clear out the trachea, while artificial respiration is vigorously performed and kept up, the opening into the trachea being kept patent by dressing-forceps or by one of the retractors above mentioned (p. 391). If feathers or brushes fail to reach and remove the membrane, trial may be made of aspiration. The best means of effecting this is by Mr. Parker's tracheal aspirator, which consists of a small glass cylinder, 3 or 4 inches long, to one end of which the end of a silk catheter is attached, and to the other an india-rubber tube ending in a mouthpiece (*loc. supra cit.*, Fig. 12, p. 98). It can be taken to pieces to facilitate cleaning. Before use a little cotton-wool is packed into the cylinder to prevent any dangerous membrane reaching the operator's mouth. Direct suction should never be performed in membranous laryngitis; where blood alone is the cause of the dyspnoea, it may of course be thus removed.

After-treatment.

This subject, neglected in most books, is often too little looked to in practice. The question of the most suitable atmosphere for the patient will first arise. By most a tent (readily improvised by converting a cot into a four-poster, by fastening on four vertical pieces of wood at the corners, joining these by four horizontal pieces, and throwing a sheet over all) is recommended, and one side of the cot being left uncovered, steam is conducted thither by one of the different forms of croup-kettles. While fully aware of the need of moisture when the atmosphere is dry, when the membrane tends to crust and become fixed, I am of opinion that the above unvarying rule of cot-tenting and use of steam is disadvantageous. The weakly condition of children with membranous laryngitis, and all that they have gone through, must be remembered. Believing that such seclusion and so little admission of air tend to increase the asthenia, and any tendency to sepsis, I much prefer to be content to keep off draughts by a screen, which allows of the escape of vitiated air above, using steam, if needful, according to the size of the room, fireplace, &c., and according to the kind of expectoration,* whether easily

* G. A. Wright (*Dis. of Child.*, p. 164) gives a useful hint from Cocks (*Arch. Paediat.*, Jan. 1884) that sudden obstruction of the tube is most often due to

brought up by cough or feathers, or viscid, quickly drying, and causing whistling breathing. If the temperature can be otherwise kept up to 60° or 65° , I much prefer to use a thin flat sponge, often wrung out of a warm solution of boracic acid. The inner tube must be frequently removed and cleansed, every hour or two at first. If the secretions dry on and cling to it, they are best removed by the soda solution mentioned below. At varying intervals between the removal of the tube any membrane, &c., which is blocking it, appearing for a moment at its mouth and then sucked back, must be got rid of by inserting narrow pheasant feathers, and twisting them round before removing them. If the exudation is slight, moist, and easily brought up by a cough or feather, sponging and brushing out the trachea are not called for, but they should be made use of when there is much flapping, clicking, or whistling of the breathing, and if this is harsh, dry or noisy, instead of moist and noiseless, two of the best solutions are sodæ bicarb., gr. v-xx to aq. \mathfrak{z} j, or a saturated one of borax with soda. These may be applied by a hand or steam spray over the cannula for five or ten minutes at a time, at intervals varying according to the relief which is given, or applied with a laryngeal brush, feather, or a bit of sponge twisted securely into a loop of wire. When any of these are used, the risk of excoriation and bleeding, and the fact that only the trachea and large bronchi can be cleaned, must be borne in mind, and with regard to manipulations for cleansing the trachea, and removing the inner tube, it is most important to remember that the caretaking may be overdone, and a weakly child still further exhausted by meddlesome interference. This point requires special attention from the surgeon in the case of some of the nurses of the present day, who seem to wish to transfer the entire charge of the patient into their own hands.

There is often much difficulty in getting sufficient food taken. The pain in swallowing, the impairment of the act, owing to the presence of the tube, &c., and thus the facility with which liquids may reach the lungs, the need of waking up the child frequently to give it food, are all facts to be duly remembered. It will usually be better to pass a Jaques' catheter (No. 4 or 6) by the nose, and then to feed the patient, at regular intervals, with definite amounts. Care must be taken to see, by the absence of irritation, that the tube is not in the larynx, and, if the above soft tubes are used, that they do not coil up at the back of the tongue.

The removal of the tube next requires consideration. It should be dispensed with at the earliest possible opportunity, either altogether, or replaced by an india-rubber tube between the fourth and ninth days. Quite apart from the danger, which is

conspissated mucus, not membrane; this thick mucus is secreted usually about twenty-four hours after the operation, and after three or four days the discharge becomes thinner and more puriform.

inseparable from a metallic tube,* of irritation and ulceration of the trachea, there is this object in getting rid of the tube as soon as possible, that the longer the child is allowed to breathe through the tube the more is the act of breathing through the natural passages allowed to be, as it were, forgotten, with the result that, on the tube being removed, asphyxia is threatened.

Conditions which impede the removal of the Tube.—(1) Prolonged formation of membrane. The longest possible period for this is probably about ten days. Patience and support are the main indications in the treatment here. (2) The larynx is crippled like any other inflamed part. (3) The air-tube is closed by granulations, usually above the cannula. More common than these is obstinate swelling of the mucous membrane. Here the tube must be removed, and astringents and caustics carefully applied from below, with the aid of an anæsthetic if necessary. (4) Closure of larynx by deep ulceration cicatrising after detachment of membrane. In such a case, with the aid of anæsthetics, the larynx must be opened up by probes of increasing size and laminaria tents introduced from below, and later on by the use of Macewen's tubes (p. 398). (5) Paralysis of the dilating crico-arytenoidei postici, or spasmodic action of the closing ones. arytenoidei or crico-arytenoidei laterales, from fear, excitement, or during effort.† (6) The commonest cause of inability to dispense with the tube is probably due to the rapidity with which the larynx falls into abeyance when a child is allowed to breathe through a tracheal cannula, the patient at this age being not intelligent enough to understand the importance of dispensing with the tube, being perhaps too young to care to talk, and, if older, not realising the need of again using its voice while all its wants are supplied. With the above condition goes a nervous dread of having the tube removed, and paroxysms of temper and struggling which rapidly produce embarrassed breathing. Any organic mischief, such as adhesions in the larynx, are, I think, extremely rare, and granulations above or below the tube are more often talked of and given as a reason for inability to dispense with the tube than really seen.

But while real organic mischief is rare and the usual cause is due to conditions which would seem to be only temporary, it is well known that, in some cases, getting a little child to dispense with the tube is a most baffling and prolonged affair. The following points are worthy of attention. Early attempts to

* Mr. Parker points out (*loc. supra cit.*) that black patches seen on the outer tube when removed may indicate ulceration of the trachea, and show the need of changing the tube.

† In a case in which I had performed tracheotomy, and was watching the child for the first few hours after the tube had been dispensed with, most urgent symptoms came on during the slight straining which accompanied an action of the bowels, the child falling off the nightstool on to the floor apparently lifeless. Artificial respiration restored the child, and the case did well.

remove the cannula, whether metal or india-rubber. A reliable nurse, ability on the part of the surgeon so as to arrange his time as to be himself frequently present at first, and, in the intervals, to be represented by an assistant who will not replace the tube before it is absolutely necessary to do so, and who can dilate the opening with a pair of dressing-forceps, and perform artificial respiration if these steps are required. Shortening the india-rubber tube, till eventually little more than the shield is worn, the child being comforted by the apparent presence of the tube. Encouraging the child to make use of his larynx by breathing through the tube and expiring through the larynx while the tube is closed. Patiently persevering efforts to get a child to talk, or in the case of a younger one to use his larynx by blowing out a spirit-lamp or using a penny trumpet.*

All this time every attempt should be made to improve the general health. Wise feeding—too frequent or too large meals provoke dyspnoea—attention to the bowels, such tonics as Easton's syrup, proper clothing, cold or tepid sponging followed by friction, change of scene and air in every possible way, especially at the seaside.

In a large majority of cases the above treatment, aided by patience, tact, and time, which allows of development of the air-passages, will suffice. In a few the attempts at removing the tube will still fail. Where this is so, and, in fact, in any case where the use of the tube seems likely to be protracted, the larynx should be dilated—a step which is brought about by simple means, as the larynx is usually merely functionless from disuse, not blocked up, or the glottis closed—by a tube through which the child is made to breathe.

In a recent case the simplest way of effecting this is, after chloroform has been given, to remove the tracheotomy tube, dilate the wound if needful, and pass upwards from it a drainage-tube or catheter with a double silk web; the upper end of this is drawn out of the mouth (with the aid of a gag if needful), and tied to the lower end which projects through the wound. The tracheotomy tube is then replaced for a day or two, and on the withdrawal of the tube from the larynx it can usually be dispensed with altogether. Another very simple and efficient means is thus given by G. A. Wright (*loc. supra cit.*, p. 165): "A flexible probe should be passed up through the glottis from below, and a piece of silk carrying a small sponge be attached to it; the probe should then be drawn out through the mouth, and the sponge carried through the larynx sweeps it out, breaks down any adhesions, and clears away mucus or any granulations."

In cases of longer standing the above simple treatment may not be sufficient, and here the use of Macewen's tubes passed

* I may advise my readers to consult a most practical paper by Dr. Steavenson (*St. Barthol. Hosp. Reports*, 1881).

through the larynx* and into the trachea below the wound should be made use of. Chloroform being given, one of the above tubes—they resemble stout gum-elastic catheters with terminal carefully bevelled openings—is passed from the tracheal opening† up through the larynx into the mouth. Having hooked this end out of the mouth,‡ the surgeon now passes the other end down the trachea beyond the wound, a step sometimes accompanied with difficulty. The object of the surgeon should be to place this lower end of the tube only just below the tracheal opening, so that air is drawn in from the end projecting through the mouth into the trachea, without leaving any needless length of the tube here or in one bronchus for fear of setting up irritation and secretion. To prevent the child pulling out the tube, the hands should be secured for the first few hours, and to prevent the tube being bitten, it is well to pass a piece of drainage-tube§ over the first few inches. This end is then secured with tapes around the head. The tube may be left in from twelve to eighteen hours according to the amount of secretion and the facility with which the tube is blocked. While this treatment is being carried out it is well to isolate the child in a separate room, as the breathing through the tube is very noisy, being often accompanied by very loud bubbling sounds, and the aspect of the child while this necessary dilating of the larynx is going on is one of apparently great distress. When it is evident the tube is clogged it must be withdrawn and cleansed, and, a little anæsthetic being given, again inserted. At any time, if needed, the cannula must be re-inserted and artificial respiration performed. It will readily be understood that during this time the presence of the surgeon, and reliable assistants who will not lose their heads, and nurses with much tact and temper, are pre-eminently required. Even when laryngeal breathing is restored and the tube has been dispensed with, the child must be carefully watched, especially at night. If natural breathing fails, it is better, whenever there is time, to replace the Macewen's tube through the larynx rather than re-insert the tracheotomy tube into the old wound, a mode of relief which is too likely to be resorted to on account of its facility, but one which tends to keep up the sinus-like nature of the wound in the trachea, and brings back that most pernicious tendency of the child to prefer and confide in this mode of breathing.

Complications of the After-treatment.

(a) *Hæmorrhage*.—This is not common; if immediate, it is due to some vessel having been left unsecured. Later on, it may be

* See a paper by Mr. Bilton Pollard (*Lancet*, 1887) on this subject.

† It is more easy to pass the tube this way owing to the facility with which the tube, when passed from above, finds its way into the œsophagus.

‡ The tube will be found to pass readily behind the soft palate.

§ This simple means is much better borne by the child than the gag. I owe its suggestion to an old friend, Arthur E. Poolman.

brought about by ulceration of the trachea by the cannula,* separation of the false membrane by sloughing; a velvety and swollen condition of the mucous membrane; or by prominent granulations. The treatment is clearly preventive, to dispense with a tube, especially a metal one, as soon as possible, and from the first to use one of appropriate length and curve (p. 389).

(b) *A Sloughy Condition of the Wound*.—If this is threatening, attention must be paid to the tightness of the tapes, so that the cannula is not needlessly buried in the wound, and to the wearing of a collar of lint behind the shield. The tube must be removed at intervals, or replaced by an india-rubber one, air tending to enter without a tube as soon as the edges of the wound are set and healing. If the wound is not only sloughy, but gangrenous and diphtheritic, in addition to frequent cleaning with a camel's-hair brush, the use of iodoform and hot boracic or zinc-chloride lotions, stronger measures, such as the application of pure nitric or carbolic acid, will be called for. The general treatment will not, of course, be neglected in these cases.

(c) *Emphysema*.†—This is usually the result of a faulty operation. The incision into the trachea is either wrongly placed—*i.e.*, it is not in the same line with that in the soft parts, or it is too small—perhaps two small ones have been made; very rarely is the emphysema due to too large an incision in the trachea. Or, the incision may have been correctly made, but some fault connected with the tube may produce the emphysema; thus it may have been originally too short, or have been pushed out of the wound by swelling of the soft parts, or by coughing. As a rule, this complication is not dangerous unless it be extreme in very young children, or unless it travel deeply; under these circumstances scarification must be made use of, if possible.

(d) *Ulceration of the Trachea*.—This is usually due to the pressure of a cannula faulty in length or curve, much more rarely to separation of membrane or sloughs. There are no definitely characteristic

* Some undoubted cases of ulceration into the innominate after low tracheotomies in children are on record—*e.g.*, *Path. Soc. Trans.*, vol. xi. p. 20.

† On this subject the reader should consult the laborious, accurate, and researchful papers of my old friend Dr. Champneys, in vols. lxxv. lxxvii. and lxxviii. of the *Med. Chir. Trans.*, and his work on *Artificial Respiration*. The following are amongst the practical conclusions with which his pages abound: (1) Emphysema of the anterior mediastinum, often associated with pneumothorax, occurs in a certain number of tracheotomies. (2) The conditions favouring this are, division of the deep cervical fascia, obstruction to the air-passages, and inspiratory efforts. (3) The incision in the deep cervical fascia downwards should not be longer than needful; it should on no account be raised from the trachea, especially during inspiratory efforts. (4) The frequency of emphysema probably depends much on the skill of the operator, especially in inserting the tube. (5) The dangerous period during tracheotomy is the interval between the division of the deep cervical fascia and the efficient introduction of the tube. (6) If artificial respiration is necessary, the tissues should be kept in apposition with the trachea, and any manipulations performed without jerks.

signs of this complication ; the following point to it : Streaks of blood expectorated a day or two after the operation, and perhaps discoloration of the lower end of the tube. This accident is especially likely to occur in cases of diphtheria, as the vitality of the tissues is here much lowered. The tube should be left out if possible, or an india-rubber one substituted, and worn as short as possible, and cut obliquely so that the end does not impinge upon the anterior wall of the trachea. If it is necessary to dispense with all tubes, attempts may be made to keep the edges of the tracheal wound stitched to that in the soft parts for a few hours, or Mr. Golding Bird's dilator may be worn.

(c) *Suppuration in Mediastina*.—This is a rare complication. When it does occur it is liable to be very rapid. It results from a descending cellulitis from the wound. The only treatment is prevention by a well-performed operation and by attention to the wound.

Other complications which are not surgical may of course be present—viz., Extension of exudation downwards. General infection. Paralysis. Albuminuria. Broncho-pneumonia, a very frequent one, known by a rise of temperature with frequent respiration and dyspnoea, dulness on percussion, bronchial breathing, with bubbling and crepitant râles.

INTUBATION OF THE LARYNX AS A SUBSTITUTE FOR TRACHEOTOMY IN MEMBRANOUS LARYNGITIS.

This is one of those new modes of treating an old disease which has not taken any firm root in this country.

Attention was called to this subject by Prof. Macewen* in 1880. It was, later on, more prominently brought forward in America.†

The **advantages** claimed, if verified, would no doubt be very great. Of these the chief are—(1) That objection on the part of friends is less likely than in the case of tracheotomy ; (2) That the tubes are easily and quickly introduced ; (3) That there is no severe and difficult operation ; (4) That the inspired air is warm and moist ; (5) That the tubes are self-cleansing ; (6) That there is no prolonged after-treatment.

The tubes used have been mainly of two kinds—(a) Macewen's long cylindrical tubes of the pattern of gum-elastic catheters.

* *Brit. Med. Journ.*, July 24 and 31, 1880. Dr. Macewen's cases were all four in adults, the two acute ones being cases of oedema of the glottis.

† Dr. O'Dwyer's first paper is in the *New York Med. Journ.*, August 1885. Mr. Symonds, in a summary of the results of O'Dwyer's method (*Brit. Med. Journ.*, Nov. 19, 1887), gives the following references—viz., Dr. Waxham (*Chicago Med. Journ.*, March 1886 ; *Journ. Amer. Med. Assoc.*, October 24, 1885, and July 23, 1887) and Dr. Ingals (*New York Med. Journ.*, July 2 and 9, 1887). Dr. Waxham's results have no doubt improved, but in the *Chicago Med. Journ. and Exam.*, November 1885, *Ann. of Surg.*, January 1886, four cases are given which were treated by him, after O'Dwyer's plan, of which only one recovered.

introduced from the mouth into the trachea through the larynx, and removed at intervals of about twelve hours for cleansing; (b) O'Dwyer's short tubes (under 3 inches) of metal with the antero-posterior diameter larger than the lateral. These are self-retaining, partly by an enlarged head which rests upon the ventricular bands, and partly by a fusiform enlargement a little lower down. They are introduced and removed from the mouth by special instruments. A gag must be used.

I am unable to recommend intubation. Within a few months of the appearance of Prof. Macewen's paper I made use of his method in three patients with membranous laryngitis, at the wish of my friend Dr. Goodhart. Every one of these came to tracheotomy, most of the drawbacks enumerated below being most strongly present. I ought to say that of Dr. O'Dwyer's tubes I have no personal experience, but I am most strongly of opinion that in children at least they cannot meet with a large amount of general success. Their necessarily narrow chink-like calibre appears to me to be certain to obstruct the free expectoration of mucus, membrane, &c., which is so essential in these cases. Even when this is liquid and abundant, I fear that the tubes will be plugged; when the expectoration is dry, thick, and tenacious, its escape must surely be impossible. I was much struck by three cases in which the more recent form of intubation was made use of with much temporary *éclat*, followed by tracheotomy, deferred, but ultimately called for, and by fatal results.

Disadvantages.—(1) The tubes are likely to become plugged; (2) There is very great difficulty in getting children to take sufficient food, as swallowing is, in them certainly, much embarrassed—the importance of getting sufficient food down in these cases has already been alluded to (p. 393); (3) Part of the liquids taken now easily finds its way into the trachea and lungs; (4) The tube may be coughed out; (5) The facilities for extracting membrane, spraying the trachea, &c., are much fewer than after tracheotomy; (6) In introducing the tubes membrane may be dislodged into the trachea, causing fatal dyspnoea unless tracheotomy is at once performed; (7) The tube, if retained for several days, as is often needful, may cause ulceration of the larynx or trachea; a fatal case of this kind is recorded by Dr. J. W. Carr (*Lancet*, 1891, vol. i. p. 713). The child here died six days after the intubation, but it is fair to add that the tube used was somewhat large, a smaller one having been coughed out.

Any one wishing to contrast fairly and practically the two operations of tracheotomy and intubation should consult a paper by Dr. R. W. Lovett, of Boston (*Med. News*, Aug. 27, 1892). The writer shows that between 1864 and the end of 1887 tracheotomy was performed for membranous laryngitis 327 times at the City Hospital, of these 95 recovered, making a recovery percentage of 29·05; 10 died during or soon after the operation, but only 4 of these from hæmorrhage. The first intubation was performed

December 31, 1886, and up till January 1, 1891, was performed 392 times. Of the 392 cases 312 died and 80 recovered, giving a recovery percentage of 20.41. Intubation was complicated with many accidents. In 21 cases, as soon as it was attempted, immediate tracheotomy was necessitated by the cessation of breathing; of these only 2 recovered. In 3 death occurred while the tube was being attempted. In 2 the tube was drawn into a bronchus and death resulted. In 2 the insertion of the tube was followed by convulsions. In 2 the introducer broke during the operation. Dr. Lovett points out that both operations were performed under most favourable conditions as far as a specially well-equipped hospital and very experienced attendants went. He adds that during the time that intubation was performed, tracheotomy was performed 139 times, with a recovery percentage of $11\frac{1}{2}$, but as these were the most desperate cases in which intubation seemed hopeless, 19 of them being moribund at the time of operation, they are not to be taken into consideration in any way. Dr. Lovett protests against intubation as a tentative measure to be followed later by tracheotomy, if the case does badly. Of these secondary tracheotomies there were 57, with but five recoveries. From the above paper of Dr. Lovett, it is clear (1) that intubation does not compare favourably with tracheotomy, as (a) the death rate of intubation is 9 per cent. higher, and (b) accidents are much more common during intubation. It must be remembered here that in each case the operation was performed by peculiarly experienced hands. (2) That if tracheotomy only is performed it should be a primary operation.

Dr. Lovett concludes that intubation fails in being as successful as tracheotomy for saving life in severe laryngeal diphtheria, for the two following reasons, mainly: (1) The amount of food taken is much more limited in most cases of intubation. To this point I have already alluded at pp. 393 and 399. (2) Intubation does not afford such good drainage to the trachea. After tracheotomy large quantities of mucus, pus, and diphtheritic membrane are expelled through the tube for several days. After intubation this does not occur. The above material may be swallowed or it may be inhaled, but it is not often expectorated. This material is highly septic, and its retention must be harmful.

While I feel, I trust sufficiently, that the results of tracheotomy for croup admit of very great improvement, I doubt if intubation will be more successful. I venture to think that this is one of those diseases in which sufficient attention has not been paid to some of the anatomical surroundings. I shall, perhaps, be condemned as holding a pessimist's views when I say that, considering the narrowness of the glottis, its proneness to spasm, the ready downward extension of the disease, the age and rapid exhaustion of the patients, I doubt if it is not expecting too much when a larger proportion of cures are looked for here, either by tracheotomy or, still less I think, by intubation.

OTHER INDICATIONS FOR TRACHEOTOMY.

(i) **Syphilitic and Tubercular Ulceration.**—Tracheotomy is more frequently called for in the first of these, in which also it is decidedly more useful. The conditions which demand it, temporarily, are, œdema of the glottis setting in on old mischief, fibroid thickenings which may, later, yield to treatment, and, more permanently, probably, deep ulceration, necrosis, and cicatricial contraction.

In tubercular mischief tracheotomy rarely gives much relief, dyspnœa being now a rarer misery than cough and difficulty of swallowing, both of which are conditions which may be intensified by the presence of a tube.

(ii) **Malignant Disease of the Larynx.**—Here tracheotomy is often called for. Till statistics of extirpation of the larynx are more complete, the question which of these modes of operative interference has the soundest basis must remain uncertain. One difficulty alone which besets this matter is scarcely to be surmounted, and that is, that an increasing number of cases shows that, to be really successful, extirpation of the larynx must be performed early, but how many patients will submit to it at this stage? (p. 411).

In deciding between advising a palliative tracheotomy and extirpation of the larynx the surgeon will be guided by the condition of the disease and that of the patient. The latter operation can alone be justified when the disease is strictly localised. Enlargement of the lymphatic glands, extension of the disease, especially in cases of carcinoma, to the pharynx, back of the tongue or tonsil, should put this operation aside. Again, the condition of the patient, how far he is exhausted, how far his strength is sufficient for such an operation as extirpation, how far he gains ground after a preliminary tracheotomy, have all to be considered.

(iii) **Acute Laryngitis.**—The rapidity with which this may run a fatal course, especially after exposure to cold in reduced constitutions, is well known. If treatment, including application of strong solution of silver nitrate and scarification of the aryteno-epiglottidean folds and adjacent parts fail to relieve the dyspnœa, tracheotomy should be performed at once to meet the increasing exhaustion.

(iv) **Certain Spasmodic Affections**—*e.g.*, **Aortic Aneurism and Tetanus.**—Owing to these diseases destroying life, usually, in other ways, tracheotomy is rarely called for here. Occasionally, however, the laryngeal dyspnœa which they bring about calls for this operation.

Probably there is no form of dyspnœa more agonising to the patient, or more distressing to the friends, than that which may accompany thoracic aneurism. The surgeon, however, when called upon to perform tracheotomy in one of these terrible cases,

must remember that the dyspnœa may be due to direct pressure upon the trachea as well as to pressure or irritation of the laryngeal nerves, that it is in the latter only that operation will give relief, and that the difficulty of distinguishing between the two, though much diminished by the laryngoscope, is not entirely removed.

I would refer my readers on this point to one of Dr. Bristowe's interesting Lumleian Lectures,* and especially to this passage: "Destruction of the functional activity of one recurrent laryngeal nerve is attended with, of course, paralysis of the corresponding vocal cord (which can be recognised by means of the laryngoscope), with impairment of the musical quality of the voice, and apparently with some difficulty of swallowing, owing to the tendency of food to slip into the trachea, but is certainly not necessarily attended with stridor or dyspnœa; in the second place, compression of the trachea involves stridor and dyspnœa, which is often paroxysmal and is liable to end in sudden death, but does not itself interfere with intonation or phonation, excepting in so far as it may render the voice weak by diminishing the supply of wind to the vocal organ." As the paroxysmal nature of the dyspnœa may then be met with in cases of pressure on the air-tube below the larynx as well as in laryngeal dyspnœa, the chief points to rely on will be the result of a laryngoscopic examination, and the freedom of the lungs and air-tube from pressure. Dr. F. de H. Hall† thinks that "the absence of respiratory excursions of the larynx" points to the chief impediment being below the glottis.

With regard to tracheotomy in tetanus, the same warning has to be given. In the rarer cases in which tetanus threatens life by asphyxia and not by exhaustion, the surgeon, before performing tracheotomy, must decide where lies the seat of the asphyxia. In the few cases which I have seen in which asphyxia closed life in this disease, the asphyxia was due to spasm of the muscles of respiration, including the muscles of inspiration and those of expiration—*e.g.*, the abdominal muscles also. The fatal spasm thus, usually, not lying in the larynx, tracheotomy seems contra-indicated, unless it were done with the object of relieving, with

* *Lancet*, May 18, 1879. Dr. Bristowe goes on to show that the exacerbations of dyspnœa in narrowing of the trachea may be due partly to spasm of the muscular fibres, but mainly to accumulation of mucus below the narrowing, and to the difficulty of dislodging it by coughing.

† *Clin. Soc. Trans.*, vol. xix. p. 82. Quoting from Gerhard (Lehrb. d. Ausc. Tübingen, 1871), Dr. Hall points out that in a case of aortic aneurism the following causes for dyspnœa (Dr. Powell, Reynolds' *Syst. of Med.*, vol. v. p. 32) may all be present together: (1) Undoubted paresis of the abductors of the cords. (2) Though the post-mortem may "not show any very distinct bulging inwards of the trachea, the aorta and sac being emptied of blood, yet I can readily believe that during life, when these parts were distended with blood, considerable pressure was exerted on the trachea, and that this narrowing led to accumulation of the tough mucus which so bothered the patient." (3) Gairdner (*Clin. Med.*, p. 486) states that paroxysms of dyspnœa, closely resembling those of asthma, may be occasioned by compression of one of the pulmonary plexuses.

the aid of artificial respiration, that congested, gorged condition of the lungs which is due to the continued spasm of the muscles of respiration. And it is to be feared that if these steps were taken, the gentle violence of artificial respiration would, as has happened with tracheotomy itself in this disease, only bring on a final and fatal spasm.

(v) **Scalds of the Upper Aperture of the Larynx.**—Tracheotomy is here usually deferred till late, and its want of success is well known. This is not, however, an instance of cause and effect, the mortality in these cases being rather due to the shock, pain, and inability to take sufficient food. Unless the case is seen late, tracheotomy should not be performed in these cases till a trial has been made of scarification, or rather of acupuncture, by means of a guarded bistoury point, of the mucous membrane of the epiglottis and the glosso-epiglottidean and aryteno-epiglottidean folds, the left fore-finger guiding the point of the instrument. In doing this the surgeon must remember the amount of dyspnoea which is already present, and the certainty that this will be increased by the struggles of the child, by the finger coming in contact with the inflamed parts above: at any moment the child must be turned on its side, artificial respiration performed, or tracheotomy at once resorted to.

(vi) **Foreign Bodies in the Air-passages.**—We will suppose a child brought to the surgeon with a history of having swallowed one of the usual foreign bodies. Two questions now call for an answer. (1) Is there a foreign body at all in any part of the air-passages? and (2) if so, where is it? In regard to the first question, it is well to remember that the history is often far from clear, especially in children, and the symptoms by no means as obvious as they are often described to be. Thus, the chief aids in distinguishing the entrance of a foreign body from such a disease as membranous laryngitis are the sudden onset and, not unfrequently, the well-marked intermissions. The symptoms characteristic of the entrance of a foreign body into the larynx—viz., the urgent dyspnoea, the cyanosis, the struggling against impending death—may not be got at on account of the youth of the patient, or because no one saw the onset; while if the body has passed from the larynx into the trachea, or into one bronchus, the dyspnoea, brassy cough, and alteration in the voice, may all have disappeared before the surgeon sees the child, and yet he will be expected to give a definite opinion. Again, the body may have been coughed up, and perhaps swallowed. Finally, in adults, usually hysterical and egotistical women, who come with a history of cancer, dysphagia, &c., owing to a pin which they aver to be in their throats, the diagnosis will be far from easy.*

* I would refer my readers to some instructive remarks by Mr. Lund on the delusive impressions which may arise from the imagined swallowing of false teeth, &c. (*Hunt. Lect.*, 1885, p. 34).

Having settled that a foreign body is really present, the surgeon, unless tracheotomy is urgently called for, tries to decide where the body is lodged. A careful examination should be made with a good light and with a finger in the fauces, and with the laryngoscope when feasible, any information about the size and nature of the body having been previously obtained.

(a) A large or irregular body, such as bolted—*i.e.*, unmasticated—food, or artificial teeth, usually lodges above the upper aperture of the larynx, and causes urgent and often fatal dyspnœa. If, however, the first attack be survived, bodies of considerable size—*e.g.*, a plate with one or two false teeth, or halfpennies—have been known to lodge near the base of the epiglottis and aryteno-epiglottidean folds for a very considerable time.

Such cases should be treated by laryngotomy to meet the urgent dyspnœa, and extraction of the bodies either by the finger, or appropriate forceps, or probangs.

(β) A small and light body—*e.g.*, a bead, a pea, or more likely an irregular one, as a bit of nutshell—may stick in the rima or ventricle of the larynx. If the first urgent symptoms pass off without operation,* the position of the body will be pointed to by the shortness of the intermissions between the attacks of spasm, and by the pain and the marked alteration of the voice.

The treatment, here, would be first to perform a high tracheotomy, and to dislodge the body from below with a female catheter or bougie of appropriate size, the cricoid cartilage being divided if needful.† If the body cannot be dislodged in this way, a partial or complete thyrotomy (p. 382) must be performed.

(γ) If the body pass through the larynx it will depend mainly on its outline and weight whether it remain in the trachea or pass into one of the bronchi. Thus, if it is light and smooth—*e.g.*, a cherry-stone—it may frequently shift its position, and then, from time to time rising into the larynx, cause spasm, and thus attacks of urgent dyspnœa, with paroxysmal cough and temporary aphonia.

In such cases tracheotomy should be performed with a free opening into the air tube, this being kept open by wire ligatures passed through the edges of the wound and tied behind the neck, or a dilator such as Mr. Golding Bird's may be inserted.

(δ) If the body is smooth and heavier it will probably fall into one of the bronchi. This subject is next dealt with separately.

* Occasionally, when the body is in the ventricle, the consequences may be very slight for a long time, especially if it is smooth and soon coated with mucus, and partly encapsuled. Mr. Durham (*Syst. Surg.*, vol. i. p. 760) mentions a case of Désault's, in which a patient, with a cherry-stone in one of the ventricles, refused operation and lived for two years, death then taking place from laryngeal disease.

† In adults, attempts at removal with the laryngoscope and laryngeal forceps, aided by a 20 per cent. solution of cocaine, may be successful.

FOREIGN BODIES IN THE BRONCHI.

Amongst these may be tracheotomy tubes,* especially ill-made ones, tubes worn too long, particularly if a low operation has been done (p. 389); pebbles; fruit stones; part of toy whistles; pieces of nutshells; &c. &c.

Site of Lodgment.—It has been shown by Mr. Goodall that owing to the septum being a little to the left and the right bronchus the larger, the foreign body usually lodges in this.

According to M. Bourdillat's statistics,† out of 156 cases of impaction 80 were in the trachea, 35 in the larynx, 26 in the right bronchus, and 15 in the left. Out of 21 cases analysed by Prof. Gross (Durham, *Syst. of Surg.*, vol. i. p. 758), in which death took place without operation, and without expulsion of the foreign body, in 4 the foreign substance was situated in the larynx; in 1 partly in the trachea, partly in the larynx; in 3 in the trachea; in 1 in the right bronchial tube; in 1 in the lung; in 9 in the right pleural cavity. Out of 42 cases subjected to operation and general treatment, the extraneous substance was situated twice positively, and 11 times probably, in the right bronchial tube; 4 times certainly, and 4 times probably, in the left bronchial tube; 7 times in the trachea and 14 in the larynx. From these statistics it would appear that the trachea, larynx, and right bronchus are the most likely places in which a foreign body will be arrested.

Evidence of a Foreign Body having lodged in a Bronchus.—Perhaps there may be a history of a foreign body in the mouth; pain dull, and heavy behind sternum, at about its junction with

* Dr. Cohen (*Inter. Encycl. Surgery*, vol. v. p. 665) thus speaks of the frequency with which these bodies have slipped in when ill-made or corroded: "This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasise the point with quite an array of references: Porter, *On the Larynx and Trachea*, p. 144; Gross, *Foreign Bodies in the Air Passages*, p. 325; Albert, *Arch. f. Clin. Chir.*, Bd. viii. S. 197; Waters, *Brit. Med. Journ.*, vol. i. 1868, p. 141; *Boston Med. and Surg. Journ.*, February 23, 1871; Buck, *Trans. New York Acad. Med.*, 1870; Pick, *Trans. Path. Soc.*, 1870, p. 416; Ogle, *Med. Times and Gaz.*, 1870, vol. ii. p. 531; Holthouse, *Lancet*, 1872, vol. i. p. 113; Ogle and Lee, *Lancet*, 1872, vol. i. p. 81; Hulke, *Lancet*, 1876, vol. ii. p. 785; Davy, *Brit. Med. Journ.*, 1876, vol. ii. p. 45; Burow, *Berl. Klin. Woch.*, No. 36, 1876; Thornton, *Tracheotomy*, p. 36; Howse, *Lancet*, April 17, 1877."

† Cohen (*loc. supra cit.*, p. 688). Dr. Cheadle and Mr. T. Smith reported (*Lancet*, Jan. 14, 1888) a case of occlusion of the left bronchus by a metal pencil-cap in a girl aged nine. Urgent dyspnoea followed at once, relieved by the passage of an œsophageal probang, the foreign body being believed to have entered the stomach. There was great pain at the time, and violent cough. By the eleventh day there was evidence of almost complete collapse of the left lung, this having commenced on the fourth day. There was no dyspnoea, but occasional short cough. The cap was believed to have lodged at the end of the left bronchus. Tracheotomy was performed through the thyroid isthmus, divided between two ligatures. The trachea was freely opened and its edges sutured to the skin. A long probe detected the cap, in the position diagnosed, with the open end uppermost. It was easily extracted with suitably curved forceps. A good recovery followed.

the second right costal cartilage;* shortness of breath, cough; expectoration; more or less diminution of breath sounds over a portion of the chest-wall;† râles; increased breath sounds on the opposite side; and, later on, evidence of inflammation and destruction of lung-tissue.

Treatment.—A low tracheotomy (p. 388) should be performed at once, and with as free an opening as possible. The edges of the incised trachea being held open with sutures of wire (not too fine), inversion and succussion should be tried, and a feather or probe passed in order to excite cough.

If provided with suitable instruments (see below) the surgeon may at once proceed to attempts at extraction, but it is well to remember the fact pointed out by Mr. Durham (*loc. supra cit.*, pp. 769, 770), that in a large proportion of the cases which have done well, expulsion has not been effected until some time after the operation.‡ Whenever a fit of coughing brings the body into view the next inspiration will draw it back again, so that careful watching and prompt use of forceps, &c., will be required.

If from its shape, or from the interval which has elapsed, the body is too firmly impacted to be expelled by exciting coughing, the following instruments should be resorted to—viz., Gross's flexible German-silver tracheal forceps, long and slender and easily bent into any curve; or Durham's forceps, equally flexible and giving a better grip.

Failing the above, stout silver or copper wire should be bent into the form of a blunt hook, or a long probe fashioned into the same shape.§ The above instruments are first used as sounds and

* The division of the trachea is opposite the spine of the third, in some cases the fourth, dorsal vertebra. In front, this division is on the level of the junction of the first with the second bone of the sternum. The root of the spine of the scapula is on a level with the third intercostal space. A stethoscope placed here would cover the bronchi, more especially the right (Holden).

† "Obstruction of the left bronchus usually produces absence of respiration over the entire lung of that side, but occlusion of the right bronchus usually produces absence of respiration over the lower lobe of that side only, the division of the bronchus taking place much nearer the bifurcation, and the foreign body rarely lodging above the point of division" (Dr. Cohen, *loc. supra cit.*, p. 671).

‡ Thus, in a case of Dr. Smith's at Halifax (*Lancet*, 1876, vol. ii. p. 148), a boy aged eight, swallowed a whistle (as thick as a penholder, and about $\frac{1}{2}$ inch long on January 8; it was not expelled till May 7, the child having, for the previous six weeks, had increasing cough and expectoration with progressive emaciation. The child recovered, and Dr. Smith draws attention to the fact that, owing to the very slight discomfort, it is doubtful if the cause would have been recognised if the impacted body had not produced a whistling sound, and thus demonstrated its presence.

§ Mr. Hulke (*Lancet*, 1876, vol. ii. p. 785) used a long piece of German-silver wire, one end of which was formed into a blunt hook about $\frac{1}{2}$ inch long, and the wire again bent about $1\frac{1}{2}$ inch above this, at an angle roughly estimated as that which the right bronchus and trachea include. The other end was fashioned into a large loop, the plane of which coincided with that of the tracheal end of the wire beyond the angle, and thus allowed it to be guided into the right bronchus.

searchers, aided by the forefinger, which can be passed as far as the bifurcation of the trachea, and the orifice of each primary bronchus, as pointed out by Dr. Sands.*

The operation should not be too prolonged, especially if the parts are inflamed: when this condition has subsided, spontaneous expulsion will often take place. Annandale† recommends that this be promoted by the patient's taking a deep inspiration; the surgeon then closes the tracheotomy wound till expiration, thus rendered more violent, follows and often drives out the body.

EXCISION OF THE LARYNX, PARTIAL AND COMPLETE (Figs. 126–130).

The value of these operations is still *sub judice*; much, therefore, of the following will require confirmation.

Indications.

(1) Sarcoma and carcinoma of the larynx, if intra-laryngeal.

The following questions must be answered when extirpation of the larynx is under consideration: A. *Is the disease malignant?* B. *How far is it advanced?* C. *Is it intra- or extra-laryngeal?* D. *Which is the wisest operation to perform—excision or a palliative tracheotomy?* To give an answer here, (1) *the results of the operation*, and (2) *the after-condition of the patient* have to be duly weighed. E. *Does the general condition of the patient justify the operation?*

A. *Is the case one of malignant disease?* B. *How far is the disease, if malignant, advanced?*—A well-known case drew attention, a few years ago, to the great difficulty of always diagnosing carcinoma and the progress which it has made. Dr. Semon has thus strongly drawn attention to this matter (*Trans. Intern. Med. Congr.*, 1881, vol. iii. p. 264). In answer to the objection that in the majority of the cases operated on the disease was already in too late a stage, Dr. Semon said: “Who, in a large proportion of these cases, will take upon himself to diagnosticate early and positively carcinoma? and who, again, if carcinoma is diagnosticated will say positively whether it is in an early or more advanced stage?”

It seems to me that we should face this difficulty, which will always lie before us, in the same way as we do elsewhere. Where a patient has suspicious symptoms, especially at a suspicious age—*e.g.*, alteration in the voice, “soreness,” pain, cough, hæmorrhage, interference with breathing or swallowing, instead of waiting to see what potassium iodide, &c., will do, we should adopt the same steps here which stand us in such good stead in cases of doubtful malignant disease elsewhere, and explore. Where such interests

* *Amer. Clin. Lect.*, vol. ii. p. 199, Putnam, New York, 1876. Quoted by Mr. Durham, *loc. supra cit.*, p. 771.

† *Med. Times and Gaz.* February 27, 1875.

are at stake, there should be no hesitation in advising opening of the thyroid cartilage and examination of the larynx. If the growth is malignant, extirpation, partial or complete, should be proceeded with at once, or a preliminary tracheotomy alone performed at this stage. If the disease is not malignant, it will very likely be the better for local treatment, which can now be effectually applied. If the thyroid cartilage is very carefully divided in the middle line, and no further operation done, we know from our experience, in adopting a similar step for the removal of certain foreign bodies, that no harm will happen to the cords, while the relief to the patient's mind will be enormous. It is only by this early and complete exploration that we can hope to attack the disease in a stage when it can be entirely removed.

As to appearance of the ulceration, Dr. Grant and Mr. Lennox Browne (*Arch. of Laryng.*, New York, vol. ii., 1881) write: "The floor of a *tuberculous** ulcer is pale and granular, and slightly depressed; the margins fairly well marked, but not deeply excavated; the surrounding parts pale and languid, and there is an appearance of a spreading process of erosion very comparable to that of the nibbling of a small rodent animal. This is due to the confluence of small ulcers produced by the slow incurable inflammation of the mucous and closed follicles of the mucous membrane, and also to the injection of minute tubercles which have worked their way to the surface. Very different from this is the punched-out areolated excavation which is seen in *tertiary syphilis*, and which may be considered suggestive of a bite rather than of the continuous nibbling to which we have likened the tuberculous ulcer. Nor need we insist on the angry, hyperæmic, thickened walls of a *cancerous* ulceration, with its accompanying deformities and other signs, to still further point the laryngoscopic diagnosis."

C. *Is the disease intra- or extra-laryngeal?* †—It has been shown, by Krishaber and Fränkel, that laryngeal carcinoma, the squamous and horny epithelioma especially, is limited to the larynx for a considerable time, and while limited to the larynx is slow to infect the glands. Extrinsic carcinomata, on the other hand, affect the glands at an early stage. The sarcomata, while rapid in growth and marked in their power of infiltrating, do not here affect the glands. The opinion has been increasingly held of late that extirpation of the larynx should only be attempted while the disease is limited to that cavity, and not infiltrating adjacent

* For a good instance of the difficulty in deciding between carcinoma and tubercle of the larynx, see *Brit. Med. Journ.*, 1888, vol. i. p. 609.

† In some cases this has only been decided during the operation, as in a case of Mr. Holmes (*Brit. Med. Journ.*, 1884, vol. ii. p. 809), in which, during the laryngectomy, part of the epithelioma was found to lie outside the larynx, extending upwards. In some cases the carcinoma is extrinsic from the first—i.e., commencing in the pharynx, and involving the larynx by invading the epiglottis or aryæno-epiglottidean folds.

structures and glands. Several cases have been recorded in which parts of the pharynx have been removed, in others portions of the œsophagus, trachea, and thyroid gland,* but the results are, with a few exceptions, far from encouraging, not only because a dangerous operation is rendered still more hazardous, but also because recurrence is usually rapid. Extirpation in extra-laryngeal cases is an operation where the surgeon may not know where to stop, owing to the extent of the disease. In deciding whether the disease is extra-laryngeal, the surgeon will be helped by observing whether the larynx moves in deglutition, and from side to side,† whether the glands are involved *vide supra*), by information gained by the finger passed from the mouth with the aid of cocaine, by the rate of the changes observed with the laryngoscope, and by the character of the growth from the first—*i.e.*, whether horny, flat, and sessile, or dendritic and papillary. Dr. Newman, in some most instructive lectures (*Brit. Med. Journ.*, 1886, vol. i. p. 816), writes: When the disease is intrinsic, “the prominent symptoms are aphonia and dyspnœa. The lymphatic glands are seldom affected; as a rule, cachexia is not a prominent feature during the earlier stages of the disease, and dysphagia is not a common symptom. In patients suffering from an extrinsic growth, on the other hand, *e.g.*, one creeping in from the pharynx, aphonia is not usually present at the commencement of the disease, and, indeed, there may be only slight alterations in the voice; while dysphagia is, as a rule, present as soon as the growth has reached any considerable size. Pain in larynx and pharynx, extending round the neck and to the ear of the affected side, is more characteristic of extrinsic than of intrinsic new formations. In the former the glands are also involved at an early period, and cachexia is usually pronounced.”

D. *Which is the wisest operation to perform for malignant disease—extirpation of the larynx or a palliative tracheotomy?*—Here we have to consider—(a) *the results of the operation*, (β) *the after-condition of the patient*.

(a) With regard to the results of the operation, I may, I think, fairly take the statistics of Dr. Hahn, of Berlin,‡ whose wide

* Thus, Czerny, quoted by Dr. Newman (*loc. cit.*), in a case of lympho-sarcoma which had perforated the thyroid cartilage and involved the neighbouring glands, removed the latter repeatedly. The internal and external carotid, the internal jugular and the vagus were divided, and the patient died fifteen months after the primary operation. Gerster's case (p. 417) is an exceptional one, and it must be remembered—(a) that the growth was a sarcoma, (b) that the removal of the larynx was partial, and (c) that the last report was only carried up to a little more than half a year after the operation.

† It is noteworthy that the larynx may be movable, and yet the pharynx be implicated, as in a case reported by Surgeon-Major McLeod (*Lancet*, April 26, 1884).

‡ A translation of his manuscript will be found in the *Journal for Laryngology and Rhinology*, May 1888. Carcinoma laryngis is the only term used for malignant disease.

experience and special opportunities in this branch of surgery are well known. They appear to me to be even more discouraging than the earlier ones, taken from many operators, which he collected previously (Volkmann's *Vorträge*, 1885), and which have been most carefully examined by Mr. Butlin (*Oper. Surg. Mal. Dis.*, p. 192). The cases are divided into three groups—

(A) *Extirpation of Tumours from the Interior of the Larynx*; (B) *Unilateral Resection of the Larynx*; (C) *Total Extirpation of the Larynx*.

(A) *Extirpation of Tumours from the Interior of the Larynx*.—By this is meant opening the larynx ("laryngo-fissure") and scraping it out, with, sometimes, application of the cautery or partial excision of the cartilages. Of the three cases, one died on the eleventh day from heart failure and pulmonary thrombosis, the patient, an unfavourable one, having urgently requested the operation. In the other two recurrence took place, one unhappy patient hanging himself.

(B) *Unilateral Resection of the Larynx*.—Of six cases, two died from the operation: of the four recoveries, recurrence took place in one; of the three others, it is stated that one remained free from recurrence a few months after the operation, and that the two others were discharged cured, one with slight indication of necrosis.*

(C) *Total Extirpation of the Larynx*.—Of six cases only one survived the operation and remained free from recurrence, this case being a brilliant triumph *as far as it goes*, over seven years having elapsed since the operation. When we remember that these are the results of a man who has had special opportunities, perhaps unequalled save by those of Billroth, and who had been working at the subject for eight years, the outlook of the operation appears to me to be extremely gloomy.

Dr. Newman (*Mal. Dis. of Throat and Nose*, 1892, p. 124), quoting from Walssermann, who has collected 219 cases of operation, states that out of 120 cases of complete removal of the larynx only 8 cases are recorded in which the patient remained well over three years after the operation.

(β) *The After-condition of the Patient*.—This is a most important matter, and one which should be fully explained to the patient. The amount of comfort will mainly depend upon two things—(1) whether half or the whole of the larynx has been removed; (2) whether much of the skin and soft parts has had to be taken away, or has sloughed.

With regard to the first point, if only half of the larynx have been removed, the patient usually swallows early and easily, and speaks quietly and hoarsely, but with very fair distinctness, and without any need of mechanical aid. Where the whole larynx

* A case, for a time most successful, by this operator on a well-known English barrister is recorded by Dr. Semon, *Clin. Soc. Trans.*, vol. xx. p. 44.

has been taken away, some such appliance as that of Gussenbauer's will be required to enable the patient to make himself understood. Much difficulty is often present in these cases in keeping open the upper part of the wound for the introduction of the artificial larynx. Even after complete removal, if the pharynx has been left untouched, the power of swallowing will be but little impaired. If, however, the surrounding soft parts have had to be widely extirpated, so large a gap will be left that swallowing will be impossible, and it will be necessary to feed the patient with a tube.

While, for the present, it must remain uncertain how far the after-condition of the patient will be better than that foretold after the earlier laryngectomies,* there is no doubt that when the soft parts in front of the pharynx have had to be extensively removed, the after-condition is one of great discomfort.†

E. *Does the general condition of the patient justify the operation?*—The age of the patient (not only to be recognised by years), his power of meeting, and of recovery after a very severe operation, the presence of any liability to bronchitis, broncho-pneumonia, asthma, his capability of assimilating food, the condition of his viscera—e.g., kidneys and liver—have all to be most carefully considered, in addition to such points as the disease; its rate of growth; the duration of any ulceration, whether it is intrinsic or extrinsic.

The *conclusions* to be drawn from the above are, I think, (1) That the operation is justifiable in the sarcomata owing to their smaller liability to infect the glands, and the younger age of the patients, and, therefore, their *à priori* better condition; (2) that it should be abandoned in carcinoma, save in the earlier stages, while the growth is distinctly unilateral, and the patient, having had all the risks fairly put before him, decides to undergo the operation. In such early stages it is probable, though more cases are required to decide the matter, that the modified laryngectomy which Mr. Butlin (p. 419) has so strongly recommended and successfully practised will be found sufficient. But these early operations will introduce questions very difficult of answer. (a) It has been shown above (p. 407) how very difficult it is for even skilled laryngologists to bind themselves to a decisive answer early in the case, and to all that may come of it. (β) Then it must never be forgotten that removal of the larynx is an operation of great severity, liable to

* Thus, Sir M. Mackenzie at the International Medical Congress, 1881 (*Trans.*, p. 263), stated that "the condition of a patient after extirpation of the larynx is usually one of great misery." Dr. Cohen, of Philadelphia, holding the same view, drew attention to the importance of distinguishing between "recovery" and mere "survival" after the operation.

† A good illustration of this condition and an idea of its results are given by Dr. Cohen from Lange, Fig. 1095 (*Inter. Encycl. of Surg.*, vol. v. p. 776). He also points out that too early attempts to use an artificial larynx only cause hæmorrhage, while an apparatus which is adjustable at first, is often rendered useless by further cicatrisation.

entail a condition of shock (especially in patients well on in life) quite out of proportion to the size of the part removed. (γ) Furthermore, this operation, especially its severer forms, apart from the question of recurrence, has special risks of its own—*e.g.*, septic cellulitis and broncho-pneumonia—and thus an early operation may, if fatal, shorten a life materially.* (δ) Statistics are in such a case especially unreliable. Thus, while all the successful operations are probably published, many of these have been insufficiently followed up, while, on the other hand, it is certain that many unsuccessful cases have never been brought forward.

A palliative tracheotomy, as soon as dyspnoea sets in, will be the wisest course in all cases unsuited to excision—*e.g.*, advanced or extrinsic ones—where this operation is refused, and in cases where the surgeon is in doubt. As the average duration of life in epithelioma here is from 2 to $2\frac{1}{2}$ years, the time still remaining after tracheotomy may be from 1 to $1\frac{1}{2}$ year. The fact must be in no way kept back or made light of that the closing months will be a time of much misery.† It will be wise to prepare the friends for this at the time when the question of operative interference, with all its risks and uncertainty, is discussed.

(ii) A few cases may arise in which there is no malignant disease, but the laryngeal cavity is destroyed, and is a constant source of discomfort and danger.

Thus, in Dr. P. Heron Watson's case,‡ a gentleman aged thirty-six, palliative tracheotomy had been performed to relieve the ulceration of tertiary syphilis. The larynx healed, but the puckering gave rise to a state of things by which some portion of all fluid nutriment and saliva made its way into the trachea and occasioned fits of spasmodic cough. Feeding by the tube did not prevent the saliva from passing down, and, in almost every instance, on its withdrawal some fluid regurgitated, and some part of it passed into the trachea, &c. The patient rallied from the operation for removal of the larynx, but died some weeks afterwards from pneumonia.

Both in this case and one in which Rubio, of Madrid, removed the larynx for necrosis of the cartilages in a man aged forty-one, with a fatal result on the fifth day, there was great debility before the operation.

With regard to this group of cases, Dr. Foulis remarked, "When the breathing and voice are impeded, and the parts are no longer

* After laryngectomy for carcinoma about two-thirds of the cases die within six months of the operation. In 21 per cent. of the whole number of extirpations death takes place during the first fortnight after the operation, from respiratory complications (Schwartz).

† In a few cases, as in one which Mr. H. Morris brought before the Clinical Society (*Trans.*, vol. xx. ; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), removal of the larynx may be called for after a palliative tracheotomy has been done : but owing to the downward extension of the growth, the tracheotomy-tube becomes a source of continual irritation and distress, though absolutely necessary for respiration and the suffocative cough and dyspnoea cannot be relieved by other means. The case is alluded to again at p. 421. The patient, a man of fifty-nine, sank on the eighth day, from exhaustion.

‡ Quoted by Dr. Foulis, *Trans. Internat. Med. Congr.*, 1881, vol. iii. p. 251.

capable of distension by dilatation, it appears to me that the diseased larynx may be properly removed and replaced by an artificial one."

(iii) It is just possible that excision of the larynx may, in the future, be performed as part of an operation for removal of a thyroid gland the site of malignant disease. It is well known how fatal removal of the thyroid gland often is in these cases from interference with the recurrent laryngeal, injury to which is often unavoidable. It has been suggested* that, in these cases, if it will facilitate extirpation of the malignant disease, or if there is reason to think that the above nerve has been injured, the larynx be removed; this not only giving more room for dealing with the original disease, but also for removing a fertile source of dyspnoea and spasm. But considering the age and general condition of these patients, it is very doubtful if this suggestion will bear fruit.

I would say that I have described here and at p. 416, and have mentioned at p. 410, several operations, because the surgeon's aim in attacking cancer here and elsewhere should be twofold. I have alluded at p. 407 to the need of early exploration and of entire removal. To ensure this the surgeon should not feel tied to perform any set or "classical" operation, but, being thoroughly acquainted with these, should do that which each case requires.

Operation.

Preliminary Tracheotomy.—This should be done a week at least before any extensive operation for excision. The advantages are that: (1) The patient gets used to breathing through an artificial apparatus. (2) The easier breathing will improve his general health. (3) The lungs, being less engorged after thus receiving air freely, will be less likely to become the seat of broncho-pneumonia. (4) When tracheotomy is performed less time will be taken up by the operation, and no blood will enter from this source. (5) The trachea will have become adherent to the skin, and thus tends less to fall away when the larynx is severed from it, so preventing diffusion of pus.

With regard to the site of the tracheotomy, it should be low rather than high, for, if done high up, (1) it may be too near the seat of the disease, and (2), a more important point, if a high operation is performed, the lower end of the excision-wound will come into parts infiltrated and altered, and thus difficult to distinguish at a very critical stage of the operation.†

* Dr. Foulis (*loc. supra cit.*, p. 258) quotes briefly a case of Dr. Bircher's, in which a scirrhus thyroid had been excised; six months later recurrence took place, and the larynx was excised with part of the gullet. Death took place in ten days from pneumonia and gangrene of the lung. Prof. Caselli (*Inter. Med. Congr.*, 1881, vol. iii. p. 262) stated that he had performed partial excision of the larynx in the case of an enormous myxo-fibro-chondroma of the hyoid and larynx, the patient, who was much exhausted, dying in three days.

† On this account Gassenbauer prefers a high tracheotomy with horizontal severance of the trachea as the initial step in laryngectomy, owing to the fact that

While the above is believed to be the wiser course, some have had good results with a high operation, performed before or at the same time as the removal of the larynx. Other operators have dispensed with tracheotomy altogether.

The patient is brought under the influence of an anæsthetic (the A.C.E. mixture, chloroform or bichloride of methylene being the best), given, if possible, through the tracheotomy tube by tubing attached to the inner tube, which keeps the surgeon and the administrator out of each other's way. The surgeon must decide whether he will perform the operation with the patient in the usual position, cutting from above downwards, or with the head supported in the dependent position, pillows being placed under the dorsal spine, the incision being now made from below upwards. Removal from above downwards, by leaving the division of the trachea to the last, more completely avoids the risk of the escape of blood and lotions into the trachea, and there is no need to use expensive and sometimes unreliable * tampon-cannulæ. A small aseptic sponge attached to silk will suffice to keep the blood out of the trachea, if placed in this tube above the tracheotomy cannula either early in the operation when the larynx is divided from above downwards, or, later on, when the larynx is severed from the trachea, as will be more convenient to most operators. If no tracheotomy is performed either some time previously or immediately before the operation, the median incision being made, the trachea is usually first isolated and divided and then a large tube inserted.

If the operation is begun from above, an incision is first made from the lower border of the hyoid bone exactly in the middle line vertically down to the level of the first or second ring of the

after a preliminary tracheotomy the tissues become so infiltrated and matted that they are less readily recognised, and also complicate the detachment of the soft parts and make hæmorrhage more serious. On this point Mr. Butlin's argument, that in patients exhausted by long-continued dyspnoea there can be no question that it is essential to success that tracheotomy should be performed some time previous to the operation, will carry great weight with most surgeons.

* Cannulæ with air- or water-tampons are liable to the serious drawback of sudden rupture. On this account it seems best to use ordinary cannulæ surrounded with aseptic sponge. Mr. Butlin prefers the tube recommended by Hahn for these reasons: (1) It consists of an inner and an outer tube, the inner of which is the longer, projecting about $1\frac{1}{2}$ inch in front of the shield so as to render the entrance of blood very unlikely. In order to prevent this projection inconveniencing the operator, it is made to bend down parallel with the trachea before it stands out at a right angle with the neck. (2) The outer tube is partly covered with a layer of compressed sponge, previously soaked in iodoform and ether (1 in 7). The sponge is fastened on by sutures and by silk tied round its upper and lower end. (3) About ten minutes after the introduction of the tube the sponge swells up from the absorption of moisture, and the entrance of liquids into the trachea is thus prevented. This arrangement of sponge seems to hold the tube more steadily in position than the india-rubber bag of Trendelenberg's tampon, which is liable to become slippery, and which, moreover, may burst during the operation. The tube and the way to use it are described by Dr. Semon (*Clin. Soc. Trans.*, vol. xx. p. 47).

trachea, and a second at right angles to the first, either at the level of the hyoid bone or across the thyroid cartilage, in either case passing outwards to the sterno-mastoids. The vertical incision should go down to the thyroid and cricoid cartilages and trachea. The soft parts over the thyroid and cricoid are then raised *en masse* by inserting a blunt dissector or raspatory so close to the cartilages that the perichondrium itself is lifted up with its relation to the soft parts over it undisturbed. This separation is carried back as far as the middle of the junction of the larynx and pharynx, the thyroid and cricoid cartilages carefully severed in the middle line with stout scissors or cutting-forceps, the two halves separated with retractors, and the interior examined to see if partial removal of the larynx will be sufficient.

The above method of working very close to the cartilages with a blunt instrument only was first used by Mr. L. Browne at the suggestion of Mr. Henry Morris; it has the conspicuous advantages of disturbing but little the soft parts and of causing but trifling hæmorrhage.* The transverse incision was not found necessary in this, a unilateral removal of the larynx.

Where the parts do not admit of the above step, or where the parts outside—*e.g.*, glands—are found involved, flaps of skin and fascia are reflected, and the larynx exposed as freely as possible, any enlarged glands now seen should be removed, and the crico-thyroid arteries secured. The sterno-hyoids, sterno-thyroids, and thyro-hyoids are next peeled off from the thyroid cartilage with a blunt dissector, or ligatured with chromic gut and cut through (the knife being kept close to the cartilage), and the lateral lobes of the thyroid gland carefully separated in the same way, ligatures being tied at their junction with the isthmus, if needful. The soft parts at the sides which contain the large vessels, &c., are now carefully retracted, and, the larynx being drawn first to one side and then to the other, the constrictors are divided very close to their attachments to the cricoid and thyroid cartilages. The superior laryngeal vessels are next secured and divided as they enter the thyro-hyoid membrane.†

The larynx is next detached from the trachea, the cricoid, or a small circle of this, being left if possible to give support later on to the artificial larynx.‡ If, however, there is any doubt as to the extent of the growth downwards, the division had better be made

* In thus raising the soft parts, by keeping close to the cartilages of the larynx, care should be taken not to separate needlessly the soft parts from the trachea. Some of these—*e.g.*, the lateral masses of the thyroid gland, which are now also detached with a blunt dissector—are useful in preventing descent of the trachea.

† Mr. Butlin, quoting from Hahn, advises that, in detaching the soft parts at the back of the larynx, blunt-pointed scissors should be used with a series of short snips.

‡ Hahn, however, removes the cricoid cartilage in complete extirpation of the larynx, as he thinks that, if left, it interferes with deglutition.

between the rings of the trachea itself. The lower end of the trachea is next to be carefully stitched to the skin, or held forwards by sutures not yet tied, and a full-sized tracheotomy tube, made sufficiently bulky by compressed gauze or drainage tube, is put in to prevent blood, &c., descending; for this purpose the end of the tube must be closed.

The removal of the larynx is next carried on from below upwards especial care being taken, in the separation of the œsophagus from its connections to the trachea and larynx, not to button-hole it (Foulis), especially at its attachment to the cricoid. During this stage the larynx is kept dragged forwards with vulsellum forceps or a sharp hook.

If, as the dissection is carried upwards, the laryngo-pharyngeal junction is found to be infiltrated, the anterior and lateral wall of the pharynx must be removed as well. If the surgeon decides now to remove the epiglottis,* the knife must be carried upward through the thyro-hyoid ligament, so as to pass between the tongue and epiglottis, its course being controlled by the left fore finger passed into the mouth. If the epiglottis is left, the knife is carried through the thyro-hyoid membrane and the thyro-epiglottic ligaments as well.

As soon as the larynx is removed, attention should be paid to any bleeding points,† and the cut trachea and edges of the pharynx (if this has been partly removed) stitched most carefully with carbolised silk sutures to the edges of the skin wound, if this has not been already done in the case of the trachea; secure union being of the utmost importance to prevent burrowing in the cellular tissue of the neck.

PARTIAL REMOVAL OF THE LARYNX

(Figs. 126, 127, 128).

As it is quite unsettled which operation will, in a larger number of cases, give the best results, the following three will be given here—viz., (A) Removal of half the larynx; (B) Modified laryngectomy; (C) Thyrotomy and removal of the diseased parts.

(A) *Unilateral extirpation of the larynx* may be made useful when, after exposing it, partially freeing it from the surrounding soft parts, and slitting it open, it is found that the disease is limited to one side.

The advantages of partial removal at present seem undoubted (1) The mortality, 33 per cent. after total extirpation, is on

* "The weight of testimony seems to indicate the propriety of sacrificing the epiglottis in all cases of carcinoma, and in all others in which an artificial larynx is to be used" (Cohen).

† Numerous Spencer-Wells' forceps and chromic gut ligatures should be at hand, oozing being checked by very hot sponges, wrung out of a mercury bichloride solution 1 in 4000. The wound should be carefully irrigated with the same solution at intervals from first to last, and a little iodoform or Jeyes' powder insufflated.

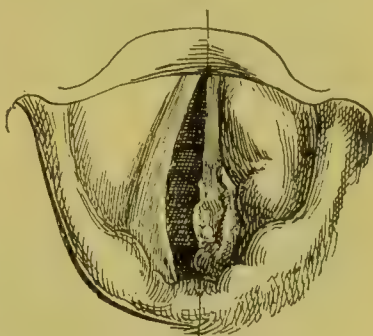
20 per cent. after unilateral;* (2) The dangers of recurrence are not greater if cases are properly selected;† (3) The voice may be almost perfectly retained without use of the tracheal cannula; (4) Deglutition is completely preserved.

Mr. Lennox Browne (*loc. supra cit.*), in his case of removal of half of the larynx (Figs. 126, 127, 128), having exposed it by sub-perichondrial raising of the soft parts, divided the thyroid cartilage with cutting-forceps, removed the half by (a) Thorough separation of the attachments to the pharynx with the raspatory aided by the knife-handle and finger-nail; (b) Division of the thyro-hyoid membrane as close as possible to its thyroid attachment; (c) Division of the left superior horn of the thyroid cartilage at its root by cutting-pliers; (d) Division in the middle line of the cricoid cartilage, in front and behind; (e) The divided half of the larynx was then separated from the first ring of the trachea, and a few nicks only were necessary to remove it entire. The very slight oozing§ which ensued after the removal of the diseased part was checked by a light application of the galvano-cautery, which would also destroy any possible fragments of diseased tissues not removed. The left arytaeno-epiglottic fold was divided close to the cartilage of Wrisberg, and the thyro-hyoid membrane close to its thyroid attachment, with the view of impairing as little as possible the action of the epiglottis. The success of this plan was completely shown by the ease with which deglutition was effected three days later.

Dr. Gerster, of New York (*Ann. of Surg.*, Jan. 1886), reports a successful case of unilateral extirpation of the larynx for sarcoma, in a patient, aged fifty-seven.

The laryngoscope showed a smooth pale tumour of the size and shape of an almond, commencing in the left glosso-epiglottidean fold, extending through the

FIG. 126.†



Epithelioma of the left cord. From a patient in whom Mr. Lennox Browne successfully removed half the larynx.

* Mr. Lennox Browne (*loc. supra cit.*) states that some thirteen or fourteen cases have now been recorded, and that in only one instance has there been an immediately fatal result.

† Drs. Hahn and Schede (*Germ. Surg. Congr.*, April 1884; *Lond. Med. Record*, 1884, p. 358) showed that (1) this operation was much less severe; (2) relapse was not more frequent; (3) impairment of function was much less. In one of Schede's cases the patient was a dentist; he could, after a while, dispense with any cannula and follow his calling, his speech not attracting notice. As a result of cicatricial contraction, a prominent fold of mucous membrane had formed, immovable, but capable of performing many of the functions of the right cord, he left moving up to it, and thus forming a rima glottidis. In the case of a well-known barrister, operated on by Dr. Hahn, and brought by Dr. Semon before the Clinical Society (*Trans.*, vol. xx. p. 44; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), the patient was able for some time to fill the position of a police-magistrate.

‡ This and the next two illustrations will be found in Mr. Lennox Browne's paper (*Brit. Med. Journ.*, February 5, 1887) and in his book on the *Throat and its Diseases*, p. 457.

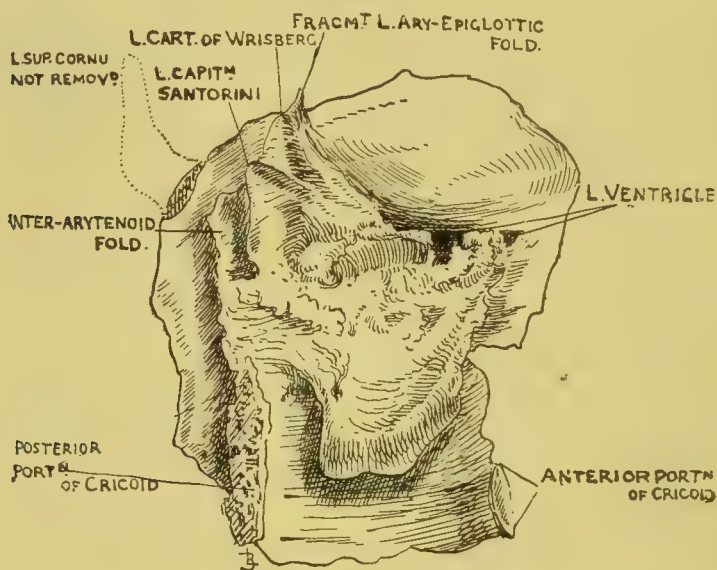
§ Only two small vessels required torsion, a happy result, due to the use of the raspatory, and to keeping so close to the cartilage.

substance of the left vocal cord into the ary-epiglottidean fold, and ending in the arytaenoid cartilage.

A preliminary low tracheotomy was performed, and at the same time a deep-seated, hard, glandular swelling of the size of a hen's egg was removed from the left sub-maxillary region, together with part of the internal jugular and the sterno-mastoid.

About six weeks later the left half of the larynx was thus removed. A tampon-cannula was inserted and distended in the tracheotomy wound; after this an incision—commencing at the upper notch of the thyroid, and extending to the lower margin of the cricoid cartilage—laid bare the larynx in the middle line. To this was added another cut, commencing in the upper angle of the first, and extending horizontally to the anterior margin of the left sterno-mastoid. The crico-thyroid ligament was split to admit a strong pair of bone-pliers for the divi-

FIG. 127.



Inner aspect of the portion removed.

sion of the thyroid cartilage, but it was found impossible to perform this act, as the strongly inclined position of the cartilage did not permit an effective handling of the instrument. Therefore, access was gained by an incision through the thyro-hyoid ligament, and an exact division of the calcified cartilage thus effected. After this the epiglottis was cut through lengthwise, the left half of the crico-thyroid ligament divided, and the superior thyroid artery included in a double ligature and cut through. The most difficult part of the operation consisted in the dissection of the lateral portions of larynx and pharynx, closely adherent to the carotid artery by cicatricial tissue, caused by the previous extirpation of the glands. Shallow incisions, running parallel with the course of the artery, were cautiously made, and the difficult task seemed almost completed, when suddenly a powerful jet of arterial blood welled up from the bottom of the wound. The bleeding point was easily secured, and then it was ascertained that the trunk of the superior thyroid (doubly ligatured further below prior to this) had been cut away level with its origin from the carotid. Two catgut ligatures were applied around the main trunk above and below the forceps, and when the instrument was removed a round hole in the side of the carotid became visible. The remaining adhesions, corresponding to the left lateral portion of the pharynx, could now be easily dissected out. The patient made a good recovery, but a plastic opera-

tion was required to close the wound, and about seven weeks after the operation a small suspicious glandular swelling was removed from the supra-clavicular region. Five months later the general condition was remarkably improved. Swallowing of solids and semi-solids was excellent; drinking had to be slowly and carefully done. The patient could speak with a hoarse whisper, readily understood at a distance of 10 or 15 feet. The cicatrices were soft and normal. The laryngoscope showed a smooth, rather extensive, scar occupying the left side of the pharynx and larynx. The right cord was normal. Two other most interesting cases of partial extirpation of the larynx are recorded by Dr. Semon (Dr. Hahn being the operator) and Mr. Butlin (*Clin. Soc. Trans.*, vol. xx.).

(B) *Modified Laryngectomy*.—Mr. Butlin in this country (*vide infra*), and in America Dr. Solis Cohen, have drawn attention to the infrequency with which the thyroid cartilage is invaded by malignant disease. Dr. G. Fowler has, accordingly, thus further modified the operation.

In a woman, aged fifty-eight, the subject of hoarseness for two or three years, which five months before the operation amounted to complete aphonia, a growth (subsequently proved to be epithelioma) was found on the left cord. On November 17, 1888, four days after a preliminary low tracheotomy, an incision was made from the hyoid bone to the first tracheal ring. The soft parts were separated (the thyroid isthmus being divided with the thermo-cautery) and retracted on either side, and, all hæmorrhage being stopped, the cricoid was separated from the first tracheal ring. The stump of the trachea was packed with gauze,

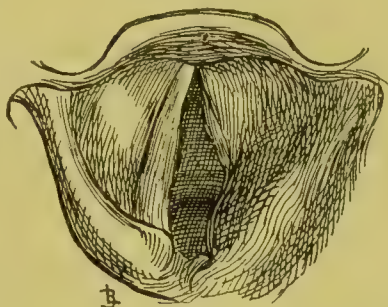


FIG. 128.
Laryngoscopic view from the same patient four months after operation.

and kept well drawn forward with a silk ligature. Each wing of the thyroid being split about $\frac{1}{4}$ inch on either side of the angle of junction, "the interior structures of the larynx were now cleared from the inner surface of the thyroid cartilage; the mucous membrane of the right side peeled off easily, but that on the left proved to be hard and somewhat unyielding, although it finally separated completely from the underlying thyroid. Both wings of the cartilage being cleared, the soft parts behind and at the sides of the cricoid, including the articulation of the latter with the inferior cornua of the thyroid, and its connection with the œsophagus, were separated; the attachment of the inferior constrictor to the posterior portion of the thyroid was not interfered with. The arytenoid cartilages were included in the parts thus dissected. Upon reaching the line of the attachment of the œsophagus to the cricoid posteriorly, the former was opened in the median line, and through the opening thus formed the left index was passed into the pharynx up to the base of the tongue and hooked over the epiglottis. The latter, together with the entire respiratory contingent, were now drawn forcibly downward, so as to identify the attachments of the thyro-hyoid membrane. The latter was now incised, and the epiglottis detached from the aryteno-epiglottidean folds, when a few touches of the knife served to release the whole mass. It was found that the entire diseased mass had come away completely."

(C) *Thyrotomy and Removal of the Diseased Parts*.—Mr. Butlin (*Oper. Surg. Mal. Dis.*, p. 191) is in favour of thus limiting the operation. "When the disease is of very small extent, limited to the true and false cords of one side, not extending into the structures above and below, not even adherent to the cartilage, I

believe the better course to pursue will be to remove the diseased structures and a wide area of the surrounding soft tissues, just in the same manner as one treats an epithelioma of the lip, without insisting on the removal of even one-half of the thyroid cartilage. Cartilage, whether calcified or not, is peculiarly resistant to the progress of cancer, and when the disease appears to be adherent to it, it is the perichondrium which is affected, and only in the rarest instances the cartilage itself. Cancer of the larynx far more often causes the death of the cartilage piece by piece than infiltrates it." While the above remarks, coming as they do from one who is distinguished for his knowledge of malignant disease, and for being one of the few English surgeons who have successfully extirpated half the larynx, are entitled to every respect, more cases are required before it is seen how far this very limited proceeding is justifiable in malignant disease. Mr. Butlin has on two occasions practised what he taught. Thus, he relates (*Clin. Soc. Trans.*, vol. xxii. p. 94) two cases of epithelioma (one in a woman aged twenty-seven) in which he successfully removed the disease without taking away the framework of the larynx.

"Tracheotomy was performed, the first four tracheal rings were divided, and Hahn's tube was introduced. At the end of twelve minutes, when the sponge was sufficiently swollen to plug the trachea (p. 414), the thyroid and cricoid were divided, and the two sides held widely apart with blunt hooks. The exposure of the growth was excellent. The disease was much more extensive than had been suspected; it occupied the commissure, the margins and under-surfaces of both vocal cords and the sub-glottic region, and penetrated deeply into the subjacent tissues, reaching in two places down to the cartilage, but not eating into its substance. I cut it out very freely with scissors, then scraped the edges of the wound with a Volkmann's sharp spoon, laying the cartilage quite bare. The larynx was left open, dusted with iodoform, and plugged with iodoform gauze. On the following day, Hahn's tube was replaced by a large silver tracheotomy tube wrapped round with iodoform gauze." The patient was fed by an india-rubber tube. Ten days later, the sides of the larynx being held apart. Vienna paste was applied to the former seat of the cancer; this produced some temporary irritation, which soon subsided, but Mr. Butlin doubts whether any good was effected, owing to the difficulty of keeping the parts free from mucus and saliva. Three weeks after the operation the tracheotomy tube was removed. In the other patient a similar operation was performed, but the cricoid was not divided; "the exposure was as good as could have been desired." The Hahn's tube was removed the day after the operation, but not replaced by another tube. Mr. Butlin kindly informs me (June, 1895) that "both these cases were well more than three years after operation."

The chief explanation of this very happy result is the fact that the disease in each case was of limited extent. The first patient was able to speak in a hoarse voice, the second in a hoarse whisper. Microscopical examination of fragments previously removed* had proved the existence of epithelioma.

* It is noteworthy that, in the next paper to Mr. Butlin's, Dr. Newman sounds the following note of warning as to a possible result of intra-laryngeal removal

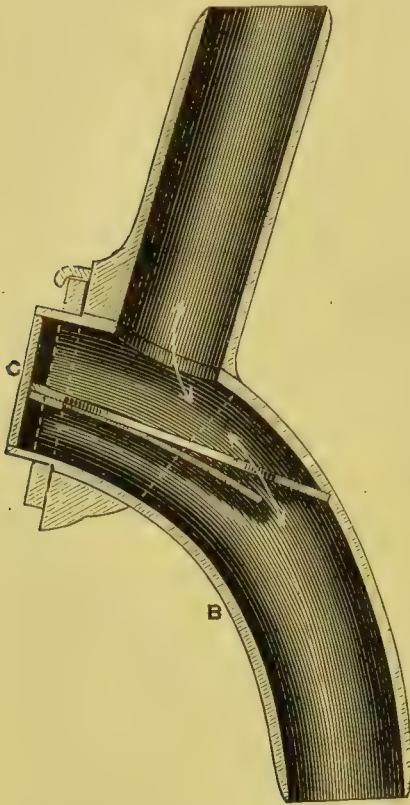
After Treatment.—All hæmorrhage being arrested, the wound is brushed over with a 10 per cent. zinc-chloride solution, or iodoform and ether, and dusted with iodoform; one or two sutures may be placed at the ends of the transverse incision, but the vertical incision should be left widely open for drainage, the wound being lightly packed with strips of iodoform gauze wrung out of carbolic-acid lotion (1 in 20). If sponges are used care must be taken not to renew them nor to sprinkle them with iodoform too often, or iodoform poisoning may develop very quickly. The dressings should not be changed too frequently, and, at each renewal, the wound should be irrigated with some antiseptic solution and carefully cleansed with camel's-hair brushes. Thiersch, to prevent lung infection, keeps the head low for the first few days. The trachea should be kept well plugged. Mr. Butlin advises that an ordinary tracheotomy tube covered with iodoform gauze be substituted for the compressed sponge at the end of twenty-four hours. The gauze should be sufficiently thick to stop any discharges getting into the trachea, and should be changed once a day. It is very important to keep the wound sweet and clean to prevent the pneumonia which has so frequently proved fatal after excision. The inspired air should be charged with antiseptic vapours. Nourishment must be supplied, for the first week, or until the wound is consolidated, by a soft tube* passed either by the nose or mouth, and, if it is desirable to retain this, it would be well to make trial of this method before the operation. Feeding by enemata alone is not reliable, considering the debilitated

of bits of growth for examination. "While, on the one hand, intra-laryngeal excision for microscopic purposes clears up the diagnosis in carcinoma, it also exposes the patient to very serious dangers by increasing the rapidity of secondary new formations. The incision of a cancerous growth, or its partial removal, has justly been regarded as a most dangerous procedure, probably because the absorption of the infective material takes place rapidly from a wounded surface. For instance, judging from my experience of other similar cases, I should say that neither in case 2 nor 3 would the lymphatic glands have become involved for months had I not removed portions of the growth with forceps. In both instances the tumour was limited in size, and in both, within a very short time after the intra-laryngeal operation, the lymphatic glands became involved. . . . While conscious of the value of removing portions of a laryngeal neoplasm for diagnostic purposes, I desire to express my strong conviction that it should not be resorted to in cases suspected to be cancer unless the patient is willing to have a radical operation performed immediately after the diagnosis is completed." A correspondence on the relation of intra-laryngeal surgery to malignant disease of the larynx will be found in the *Brit. Med. Journ.*, 1887, vol. ii.

* In a case of total excision of the larynx by Mr. Morris (*Clin. Soc. Trans.*, vol. xx. p. 37) feeding with an œsophageal tube became necessary about the second day, owing to nutrient enemata not being retained. The patient took the strongest aversion to the tube, and Mr. Morris thought that the depressing influence upon the patient due to the loss of power of swallowing, and the prospect of having to submit to the use of the tube for some time, was not to be exaggerated.

condition of these patients, and the profound shock which often accompanies this most serious operation.

FIG. 129.



Dr. Foulis' modification of Gussenbauer's artificial larynx. A pharyngeal tube is seen above. B, A tracheal cannula, the two having apertures by which they can be passed through each other and admit a free current from below upwards. C, An adjustable plate carrying a vibratory reed. This is detachable to allow of its being cleansed from mucus, being pushed in and out like a table-drawer. The apparatus being in position, the expiratory current, on its way to the mouth, sets the reed in vibration, and the tone thus produced, broken with articulate speech, is monotonous, modulation being impracticable. (Mackenzie.)

The temperature of the room must be from 65° to 70° . A moist carbolised sponge or layer of gauze should be kept in front of the tracheotomy tube. When the wound has become firm, the patient should be encouraged to take some solid food by the mouth, liquid food thus taken having, always, a greater tendency to get into the trachea.

After partial removal, the patient will be able to dispense with the cannula, and to take food by the mouth within a few days of the operation. In about a month, an *artificial larynx* may be fitted. Of these the chief forms are Gussenbauer's, and Irvine's modification of this.

The following account is taken from a very complete, clear, and practical article by Dr. Cohen,* of Philadelphia, to which I am already much indebted for information.†

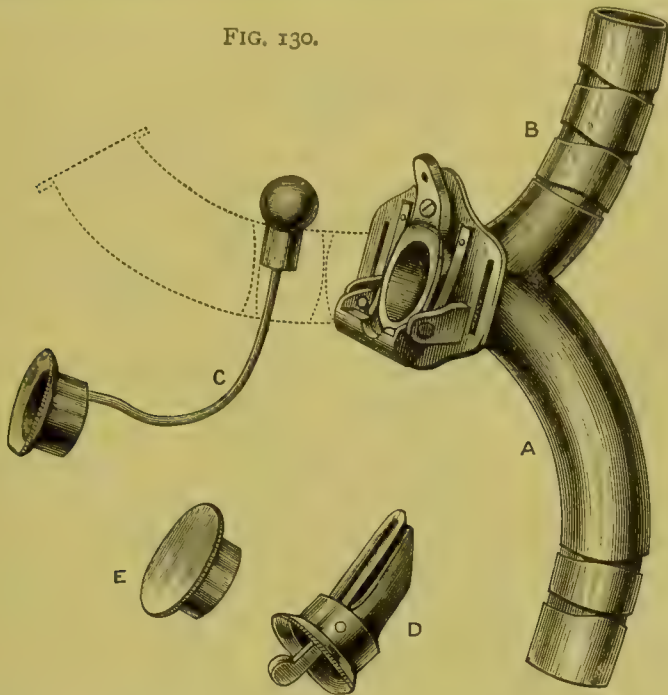
In an interesting case under the care of Dr. Macdonald and Mr. Symonds (*Clin. Soc. Trans.*, vol. xxii. p. 253), the patient, after complete laryngectomy, could speak in a loud, though rough, voice, which was not monotonous. This was produced by the vibration of two folds of mucous membrane of the pharynx. The patient could speak better without than with an upper tube, but the latter was necessary to keep the channel open. The dates in this case are as follows. The left half of the larynx was removed Oct. 1888, an uninterrupted recovery taking place. Dyspnoea soon after appeared, requiring tracheotomy Dec. 16. It was found that the right side of the larynx was attacked by

* *Internat. Encycl. Surg.*, vol. v. p. 777.

† Originally a substitute for the epiglottis was provided, maintained erect by a watch-spring weak enough to yield readily to the descent of the base of the tongue in deglutition. This has been found unnecessary and rather in the way. Dr. Cohen (*loc. supra cit.*) figures an instance of the very complicated apparatus which will be required when the anterior wall of the œsophagus has been removed.

rapid and extensive growth, and the larynx was completely extirpated Dec. 22, seven weeks after the first operation. The recovery was again an excellent one.

FIG. 130.



Gussenbauer's artificial larynx.* (Park.) A, A large tracheal tube with rings below, corresponding to the natural flexibility of the trachea. Through its front plate and through an opening on its upper curvature passes a pharyngeal tube (B), made also flexible or not, according to the case, with an opening on its lower curved surface, so placed that a stream of air may play freely through both tubes, even though the external outlet be closed. The upper end of the pharyngeal tube lodges behind and below the epiglottis (if left), or behind and below the base of the tongue. Around it the œsophagus granulates and closes, so that, when healing is complete, the only passage from the pharynx into the trachea is by way of the metal tube. In order that fluids and solids may not pass through this, an obturator (C) is provided, which is passed through the external opening and up through the tube, so that its rounded upper end plugs the upper end of the pharyngeal opening, thus preventing the passage of anything into the trachea. But since this would also shut off the air, the obturator is attached below, not to a solid plug, but to a ring, as seen, which fits accurately into the external opening of the instrument, through which the patient breathes as long as the plug is worn. Except at mealtimes a simple stopper (E) is worn, so that at all other times he breathes naturally through the nose and mouth. After a time, by education of the muscles, the upper end of the tube is protected during deglutition, and patients learn to swallow readily without the obturator. A substitute for the vocal cords is provided by a free metallic reed, playing freely in a movable slotted bar (D). This movable bar carrying the reed has an external lever, by which the wearer can, with a touch of the finger, throw it in and out of the air-current, and thus—as it were—voluntarily open or close the glottis. The sound thus produced by the reed in the air-current is converted by the articulating parts above into distinct speech, the voice, though a monotone, being a perfect voice, save in pitch.†

* Dr. G. Fowler (*Amer. Journ. Med. Sci.*, 1889, p. 369) advises that this should be made of aluminium rather than silver or hard rubber, on account of the lightness of the former metal.

† Park, "A Successful Case of Total Extirpation of the Larynx," *Ann. Surg.* Jan. 1886.

June 19, 1889, a growth the size of a hen's egg occupied the lower half of the right anterior triangle. July 5 it is reported that the patient appeared to have but a few weeks to live.

Great difference is presented in the toleration of these appliances. In some instances they give little trouble, and are used with great comfort. Some subjects bear the naked apparatus well, but cannot tolerate the phonal reed, which may impede respiration, may become obstructed with desiccated mucus, and may yield a tone to every breath of expiration. Some abandon them altogether, and stick to the simple tracheal cannula. In some instances saliva, mucus, and food will get into the tubes and descend into the trachea. Some patients prevent the escape of food by plugging the upper orifice when they eat.

Dangers and Causes of Death.

1. Shock. 2. Exhaustion. Both these are rarely met with, save when the hæmorrhage has been severe. 3. Suffocation from blocking of the tube during the first few days. 4. Lung trouble—viz., broncho-pneumonia, purulent bronchitis, &c. This is the most frequent cause of death, from the passage of food, blood, &c., down the trachea in spite of careful plugging.* Dr. Cohen thinks that the period of danger from lung complications does not last over two weeks, and that if the patient survive this date, he is tolerably secure up to the fourth month, when death from recurrence begins to be imminent. 5. Septic cellulitis, mediastinitis, &c., only to be met by the most unremitting use of antiseptic precautions. 6. Secondary hæmorrhage. This occurred in Dr. McLeod's case (*loc. supra cit.*) on the fifth day, causing death rapidly. Its source could not be determined. The disease was extensive. 7. In two cases, certainly, of partial excision of the larynx, stenosis has followed (*Ann. of Surg.*, 1891, vol. xiii. p. 66).

* If the patient have, previous to the operation, any bronchitis, these fatal lung complications are especially likely, the bronchitis running on into broncho-pneumonia. For this reason Billroth (*Clin. Surg.*, p. 134) urges in such patients that every attempt should be made to improve the bronchitis, a preliminary tracheotomy being performed if needful.

CHAPTER XIII.

OPERATIONS ON THE THYROID GLAND.

REMOVAL OF THE THYROID GLAND,* PARTIAL AND COMPLETE.

Indications.

1. Failure of previous treatment and increase of bronchocele, leading to 2. Dyspnoea sufficiently constant to prevent the patient from following any active employment, or one of a sedentary kind which involves stooping of the neck and head. 3. The existence of tracheal stridor, especially if accompanied by much enlargement of the isthmus (see p. 435), or extension of the lobes laterally or downwards.

I have met with one excellent case of lateral compression of the trachea by the thyroid. The patient was sent to me by Dr. Fraser of Romford. Here the marked tracheal stridor, breathlessness on any exertion, but only weakened voice, were accounted for by the windpipe being in this case an excellent instance of "the scabbard trachea," the tube being bluntly keel-like in front, with concave surfaces from the strap-like pressure of the enlarged isthmus. The sides of the thyroid cartilage showed, from the same cause, very marked concavities. An excellent recovery followed removal of the isthmus and one lateral lobe, and the patient, instead of being a nervous, exacting invalid at home, was able to take up work as a nurse in one of the London hospitals.

4. Attacks of sudden, suffocating dyspnoea.

It is not yet sufficiently recognised by the profession that a bronchocele, whether moderate in size or large, may from some sudden engorgement or rupture cause urgent and fatal dyspnoea. A first attack may here only herald in the end.†

The following may be quoted to prove that the above danger is well founded:

* A distinction must always be made in these operations between removal of parts of the thyroid itself and that of encapsulated adenomata in it (p. 438) however large.

† Thus, in one case, a woman with a bronchocele which, as far as was known, had not given previous trouble, waking out of sleep suddenly, was terrified by seeing her little child playing about the room with a piece of wood taken alight from the fire. Most urgent dyspnoea set in, and before surgical relief could be given, death took place from suffocation. In another case, that of a woman, the subject of a bronchocele, and straining violently in the throes of parturition, similar dyspnoea set in as rapidly, and with the same result.

Dr. Hurry (*Lancet*, March 19, 1887) relates the case of a girl, aged thirteen, the subject of a moderate goitre. Dyspnœa was first complained of November 3, on November 7 dyspnœa was urgent, and tracheotomy was called for. The operation gave very little relief, and death followed $1\frac{1}{2}$ hour later. The autopsy showed a moderately large goitre, the two lobes of which entirely encircled the trachea and reduced the lumen to a narrow slit, to which the tracheotomy wound did not quite reach.

Dr. Hurry gives the following ingenious explanation of the insidiousness and urgency of the dyspnœa in these cases: Owing to the slowly progressive enlargement of the thyroid the dyspnœa at first is slight; one day some extra exertion calls into play the additional muscles of respiration—*e.g.*, sterno-mastoid, sterno-thyroid, sterno-hyoid—which, pressing on the trachea, still further close its lumen, already narrowed by the slowly progressive growth. This brings about additional dyspnœa, and so induces more vigorous contraction of the inspiratory muscles, and so further closure of the trachea, and finally fatal dyspnœa.

Dr. Dewes (*Brit. Med. Journ.*, January 18, 1879, p. 84) records the case of a patient who was found by the Coventry police apparently dying of suffocation. On his admission into the hospital a large bronchocele was found, and a free median incision was made by Mr. Read down to the tumour. The breathing at once improved, and soon became natural, the tumour decreased in size and all went well till the evening of the seventh day, when the dyspnœa suddenly returned, the tumour again enlarging, and the patient dying in two or three minutes. It was found at the autopsy that in the last agony the posterior part of the tumour had broken down, giving rise to a large extravasation of venous blood, pressing on the respiratory nerves. "The only part of the trachea at all approachable was under the manubrium sterni, where it was covered by the innominate artery."

I wish to draw attention to another fact, that extravasation may take place suddenly into a bronchocele, thus producing urgent dyspnœa.

In 1885 a woman, aged forty-four, came under my care with enlargement of the thyroid, the right half having been increasing in size for some years, but her chief trouble was due to a swelling, in the position of the isthmus, of the size of a small orange. This had existed about a year, but had suddenly increased in size, while the patient was singing, six months before. The patient's voice, originally an alto, was now hoarse and gruff, and of very small compass. Removal of the isthmus showed that this was occupied by a cyst, containing in the centre firm coagulum. Two years later, when the patient was last seen, the right lobe had subsided to the size of its fellow, but the voice was still deep, and somewhat hoarse.

5. Dysphagia, if associated with the others now given.

6. Steady or rapid enlargement, with or without dyspnœa, if the enlargement be in a downward direction so as to become sub-sternal. The lower down the growth has been allowed to extend the greater the risk of mediastinal cellulitis, if removal of the bronchocele is attempted, and the smaller the hope of giving relief by tracheotomy, if the dyspnœa comes on in these cases too urgently to admit of an attempt at extirpation.

The following case, given by Mr. Bryant (*Surgery*, 2nd edit., vol. i. p. 192), is a good instance of the truth of the above :

A young man, aged nineteen, three months before his death, "became the subject of paroxysmal attacks of asthmatic dyspnœa, associated at times with a wheezing or whistling respiration, and some general enlargement of the base of the neck. Three days before his death this difficulty became extreme, the paroxysms became more frequent and more severe, and on the day of his death a severe paroxysm took place, which passed on to a forced and heaving respiration, beyond anything I had ever before witnessed, and speedy death resulted. I performed tracheotomy with the slender hope that some light might be thrown upon the nature of the case to guide us in its treatment, if not to give relief, but in doing so what was probable before became evident—viz., that the obstruction was below. I had no perforated instrument with me long enough to force down, so a female catheter was used, but it struck against some solid body that prevented its progress. After death the thyroid body was found to be much enlarged, but mainly below the sternum and along the sides of the trachea. The trachea below my opening was flattened laterally to within $\frac{1}{2}$ inch of the bifurcation; it was also twisted to the left, and was surrounded by the greatly enlarged and firm lateral lobes of the thyroid."

7. Inability to stoop without "a sensation of blood to the head," dizziness.

This was very marked in a man, aged forty-eight, sent to me by Dr. Graham, of Pulborough, with general enlargement of the thyroid, especially of the left lobe. Removal of this and the isthmus was followed by great shrinking of the right lobe, the patient being enabled to follow his occupation of brickmaking in comfort.

8. Inability to sleep lying down.

A woman, aged thirty-eight, under my care, whose mother had died at forty-three from suffocation by a bronchocele, was much troubled by the above symptom. Entire relief followed removal of the largest lobe and the isthmus.

9. Constant dragging pain in the neck. This will be met with in large and weighty tumours.

10. Improvement of personal appearance. An operation should never be here entertained by the surgeon, unless he is dealing with a small growth and has sufficient reason to have confidence in himself and his patient to be able to keep the wound aseptic from first to last.*

11. Exophthalmic goître. Surgical interference here is considered at p. 440.

Cases in which an operation is contra-indicated, or in which it must be performed with additional caution.

1. Huge bronchoceles, especially if broadly fixed. 2. Calcified bronchoceles. 3. Those with ill-defined limits. 4. Those which are already sub-sternal, owing to the risk of mediastinal cellulitis.

* The following is the advice of Billroth: "Large prominent bronchoceles in people above forty years of age, with slight or no dyspnœa, should not be operated on just for the sake of appearance. I think that small bronchoceles connected to the lower part of the thyroid in children and young people should be more often removed, especially when their situation is such that the tumour might, with increased growth, possibly entail some danger."

5. Age—*e.g.*, in patients over fifty. 6. Patients with very feeble pulse. Schwartz thinks that feeble action of the heart will be often met with in goitre, and attributes this partly to interference with respiration due to pressure on the veins and the trachea, and partly to the intervention of a more or less voluminous vascular network in the circulation, thus producing a strain on the heart.

Dangers of the Operation. Immediate and Later.

1. Hæmorrhage. This can usually be met by paying careful attention to the details given below in the account of the operation. The arteries are usually easily commanded; it is the veins which give trouble, being numerous and thin-walled, and, in the severer cases, met with at every step of the operation. In these cases also, when the growth is soft as well as vascular, any opening of the capsule is liable to give rise to flooding of the wound with blood and great difficulty in finding the bleeding point, thus causing risks of including in the ligature or otherwise injuring important parts, such as the recurrent laryngeal. Even in the removal of a small tumour, if soft and rapidly growing, most severe hæmorrhage may be met with.

Thus, Mr. Foy (*Dub. Med. Journ.*, 1888, vol. i. p. 242), after shelling out a tumour the size of a hen's egg, met with such copious bleeding that the application of seven clip-forceps gave "no appreciable check to the flow." The wound was plugged with new sponges, kept in place by uniting the wound with wire and figure-of-eight sutures. The patient recovered.

2. Injury to the recurrent laryngeal nerve, asphyxia, aphonia. This most grave accident has happened with sufficient frequency to put any surgeon on his guard. The injury may be due to including the nerve in a ligature, cutting the nerve, or seriously bruising it. Richelot,* writing in 1885, found nine cases in which it was certain that the recurrent laryngeal had been cut during the operation. He gives the following causes of aphonia after the operation:—(1) Wound of inferior laryngeal nerve; (2) dragging of this nerve; (3) perhaps section of the crico-thyroid branch of the superior laryngeal; (4) months after operation it may come on from inclusion of the inferior laryngeal nerve in the cicatrix; (5) when the laryngeal symptoms are progressive from ascending neuritis (Schwartz). This may be present before the operation, and so, too, may be (6) compression of the inferior laryngeal by the goitre.

Whatever the exact cause is, it is certain that the dyspnœa and aphonia are not always permanent.† On this point the two following cases of M. Richelot, and mine at p. 429, are of much interest:

In a woman, aged twenty-five, suffering from suffocating dyspnœa, the operation was followed by aphonia, which lasted for three months, and by complete paralysis of the cords. The operation was performed with great care, and there

* *L'Union Méd.*, Nos. 17 and 18, 1885; *Med. Chron.*, June 1885.

† Owing to the definite supply given to the muscles of each side by the corresponding nerve, actual laceration or division of the nerve will be followed by equally definite paralysis.

is no reason to think that either of the recurrences was cut, but it is possible that they were bruised or stretched; however, in four months the cords regained movement and the voice was fully restored.

In the second case, aged twenty, a hard, mobile tumour, the size of a walnut, was attached to the isthmus by a narrow pedicle, and the gland itself, though apparently somewhat hypertrophied, was not prominent. But, when exposed, it was found that the tumour had a broad attachment to the isthmus, and that the two lobes of the thyroid were greatly hypertrophied, closely embracing and compressing the trachea; it was therefore thought desirable not only to remove the tumour, but also to dissect out the whole gland. When recovering from the effects of chloroform, the patient was suddenly seized with cyanosis and threatening asphyxia, and though she partially recovered, on the next day there was aphonia, dysphagia, and uninterrupted dyspnoea, and she died asphyxiated in the evening. Both recurrent laryngeals had been cut, and the upper end of the left one was included in a ligature.

In June 1894, this being my fifteenth case of removal of the isthmus and one half of the thyroid, I met with this complication, which was, however, not permanent. The patient was aged thirty-five, the subject of an ordinary solid bronchocele, but of very large dimensions, the right lobe being 7 inches long. The voice was decidedly weak before the operation, but while this presented no difficulties and was not accompanied by any cyanosis, dyspnoea, &c., it was followed by marked aphonia, the voice being now almost reduced to a loud whisper. The right vocal cord was now found to be motionless. Complete recovery had taken place when the patient was last seen in April 1895.

Injury to the nerve is especially likely to occur under the following conditions: (*a*) when the growth is huge; (*b*) when it is very fixed by adhesions (which are uncommon), or by a broad base; (*c*) when it is ill-defined; (*d*) when it encircles the trachea and oesophagus closely; (*e*) when it is malignant.

3. Septic cellulitis leading to purulent and diffused mediastinitis. These are very likely if the wound becomes septic. In such cases the latter complication is almost certain, even in small goitres, if they dip down behind the sternum, owing to the difficulty of providing adequate drainage. The accompanying symptoms are: Pain in the region, coming on soon after the operation and increasing, followed by feebleness of the pulse, distress, and dyspnoea, and speedy death.

4. Myxœdema, both acute and more deferred. This strange condition, which has so unexpectedly overclouded otherwise successful operations for complete removal of an enlarged thyroid gland, was first noticed and published by two Swiss surgeons, Kocher and Reverdin.* The correct explanation will probably be found to be the one which Prof. Horsley brought before the profession in his lucid and convincing Brown Lectures of 1885.†

* *Arch. f. Klin. Chir.*, Bd. xxix. S. 254, 1883.

† *Brit. Med. Journ.*, January 17 and 31, 1885: "The Thyroid Gland: its Relation to the Pathology of Myxœdema and Cretinism; to the Question of the Surgical Treatment of Goitre; and to the General Nutrition of the Body."

The issues here treated are so wide, the experimental researches are so complete and far-reaching, that any abstract must, unintentionally, seem to do them an injustice. The following are the points of chief importance to the operating surgeon:

Effects of Excision. Phenomena following Complete Thyroidectomy in Monkeys.—"At a variable period after the operation, but averaging five days, the animal is found to have lost its appetite for a day or two, and, on closer examination, to exhibit slight constant fibrillar tremors in the muscles of the face and hands, and feet more especially. These tremors disappear at once on voluntary effort. At the same time, the animal is noticed to be growing pale and thin, in spite of the appetite, &c., returning quickly with great increase; rapidly the tremors increase, affect all the muscles of the body without exception, the animal becomes languid, paretic in its movements, and imbecile. Then puffiness of the eyelids and swelling of the abdomen follow, with increasing hebetude. During these last stages the temperature, gradually falling, becomes sub-normal, and then the tremors disappear as they came. Meanwhile the pallor of the skin often becomes intense, and, leucocytosis having been well marked, oligæmia follows, and the animal dies perfectly comatose in a variable period, but usually about five or seven weeks after the operation."

Post-mortem Appearances met with after Complete Thyroidectomy.—Prof. Horsley thus sums these up: "Ablation of the thyroid causes atrophic changes in the central nervous system, and in the fat generally. It causes an increase in the general connective tissue, and a mucoid conversion of the ground substance. This increase of mucin in the connective tissue is accompanied by an extraordinary secretion of the same stuff by means of the salivary glands, and also those of the alimentary canal."

While these changes are going on, the hæmopoietic tissues, especially the spleen, are found to have undergone obvious compensatory hypertrophy.

Theories explaining Myxœdema, Cachexia Strumipriva, and Cretinism.

Prof. Horsley discussed the three following, he himself maintaining the third to be the correct one:

i. Kocher's view, that the symptoms of myxœdema which follow complete thyroidectomy are brought about by chronic asphyxia, due to narrowing of the trachea, consequent on softening and atrophy, produced by ligature of the thyroid vessels which supply the trachea and œsophagus as well. Prof. Horsley finally disposes of this view by remarking that there are numerous cases of marked stenosis of the larynx and trachea on record, but not a symptom of myxœdema has here been noticed. Furthermore, in his experimental thyroidectomies, the larynx and trachea were found absolutely normal and patent.

ii. Dr. Hadden's view that the myxœdematous state of mal-nutrition is brought about by a general spasm of the arterioles and capillaries, the spasm being maintained by central disturbance in the sympathetic ganglia. This view regards the atrophy of the thyroid as due to constriction of the blood-vessels, and therefore of secondary importance. It has been accepted by Kocher on the assump-

tion that in the operation the sympathetic nerves are injured and irritated by being included in the ligatures placed on the vessels. It is set aside by Prof. Horsley because (α) it has been found experimentally that, if the gland be exposed, and the nerves going to it are divided, the symptoms of myxœdema do not appear; (β) in Prof. Horsley's experimental thyroidectomies which were followed by myxœdema, the irritation of the nerves was only, he considers, momentary; (γ) the sympathetic trunk and ganglia appear to be, microscopically, absolutely normal.

iii. The theory * that the varieties of a general state of mal-nutrition, given below, are due to the loss of function of the thyroid gland, perhaps through disturbance of the nervous centres, leading to vaso-motor or trophic changes in the tissues.†

Further detailed and most interesting information is given by Prof. Horsley "The Functions of the Thyroid Gland" (*Brit. Med. Journ.*, 1892, vol. i. pp. 215, 265), and in his Report as a member of the Clinical Society's Committee on Myxœdema, 1888. In the former of these papers (p. 267) he states his view as to the explanation of the myxœdema which may follow on complete thyroidectomy as follows: "The thyroid gland possesses a power of metabolising certain intermediate waste products; if this metabolism should be interfered with, the consequence was disorganisation of the chemical changes (more especially those of the connective tissues) resulting in the imperfect performance of their normal

* Prof. Horsley also deals with some objections which have been raised to his theory—(1) Even if in the above-named conditions—viz., cretinism, myxœdema, cachexia strumipriva, and cachexia after thyroidectomy—a thyroid body be discovered post-mortem, it does not follow that this was in full normal function. (2) If one lobe be excised, the other hypertrophies; if this enlarged half be now removed, the animal presents many of the symptoms described. In answer to the statement of Schiff that, provided an interval of about three weeks elapses between the operations, the symptoms do not appear, or, at any rate, are not fatal, Prof. Horsley replies that even if the above observation is to be trusted the mitigation of symptoms can readily be understood, as the spleen will have had time to provide for the hæmapoietic functions of the gland.

† Prof. Horsley thus tabulates the most striking of the anatomical and physiological facts bearing upon experimental myxœdema:

"1. The thyroid gland appears to consist of two distinct portions—(a) glandular, consisting of highly vascular acini, which excrete into their interior a mucoid substance, this substance, or something closely similar, being found in the lymph-vessels of the gland—mucin-excreting function? (b) highly vascular, lymphoid nodules—hæmatogenous function.

"2. Excision of the gland is followed, according to my experiments, by an increase in the amount of mucin in the tissues which normally possess it, by a retrograde histological change, by an increase in the activity of the glands which normally excrete it, and, what is still more striking, by the assumption of the muciparous function by a gland which normally produces none, or very little mucin—the parotid gland.

"3. Excision of the gland is followed by profound changes in the blood—namely, a diminution of the number of corpuscles, preceded, as regards the number of the white elements, by a temporary increase in their number, by an alteration in the coagulability and albumins, and by an abnormal presence of mucin.

"4. Excision of the gland is followed by nerve-symptoms indicating changes in the lowest motor centres, these changes causing tremors, with rigidity and paresis; it is also followed by changes in the higher psycho-cortical centres, such producing imbecility, and, ultimately, death in the comatose state."

processes, and consequently in their exhibiting this form of mucinoid degeneration."

The following cases, with the results of operation, support Prof. Horsley's views. They might be multiplied by other published cases, and it is probable that many other temporarily successful thyroidectomies have been followed by myxœdema, but that this ending of the cases has not been made known.

Volkovitch, of Kiev (*Lond. Med. Record*, 1885, p. 148), removed the whole gland, in a woman aged thirty-eight, for dyspnœa and dysphagia indicating operative interference. Death took place four months later, with marked evidence of cachexia strumipriva—i.e., anæmia and weakness, tetany of hands and legs setting in five days after the operation, and becoming, later on, more general, numbness of hands, myxœdematous condition of the integument, striking apathy, and difficulty in articulation and respiration.

Sir W. Stokes (*Brit. Med. Journ.*, October 16, 1886) has published a case in which a somewhat similar fatal result followed complete thyroidectomy. A healthy woman, aged eighteen, was admitted with extensive enlargement of both thyroid lobes, causing urgent dyspnœa, especially at night. It was found impossible to remove more than the left lobe owing to the profuse hæmorrhage, which almost proved fatal. A good recovery took place, followed for a while, by relief of dyspnœa and diminution in the size of the right lobe. In about six weeks, however, the right lobe was as large as before, and the thrill and dyspnœa were again present in an intensified form. The right lobe was removed with even greater danger from syncope. Within a fortnight convulsive seizures set in, and "fatty" swellings were noticed about the eyelids, backs of the wrists, and over the metatarsi. Mental torpor also appeared, and the aspect of the face became gradually one of imbecility. The convulsive seizures recurred, with lividity of the face, stertor, dyspnœa, protrusion of eyes, dilatation of the pupils, and throbbing of the carotids, followed by copious perspiration. The patient became weaker and died, with symptoms of pulmonary infiltration, ten days after the second operation. The very brief account of the autopsy only mentions the brain, heart, and lungs; of these, the two former "contained nothing abnormal, the lungs were highly œdematous."*

Mikulicz, of Cracow, states that the published cases of cachexia strumipriva after thyroidectomy already number thirty-five, and he adds another. As to other evils which may result from total thyroidectomy, he says that Weiss, in 1883, found thirteen cases of tetany, and Mikulicz himself has had four cases in seven operations. He also cites three cases, two of his own, in which epileptic convulsions followed total extirpation.

It is right to state that other observers have failed to trace the above sequence. Foremost among these is the experience of Billroth, who, in 1883, had performed extirpation sixty-eight times, with a mortality of only 7.3 per cent., and without once observing cachexia strumipriva. Crêde, of Dresden (*Congress of German Surgeons*, 1884), reported fourteen cases of complete extirpation without one case of myxœdema following.

In the laborious Report of the Clinical Society on Myxœdema it is stated (p. 171) that myxœdema with cachexia followed in about

* In a similar case I would advise either ligature of the vessels to the remaining lobe, or removal of half of this.

33 per cent. of all cases of complete thyroidectomy, Many cases will be found there quoted.

However this matter may finally be cleared up, the fact remains beyond dispute that in many parts of Europe symptoms akin to those of myxœdema have followed complete thyroidectomy.

Prof. Horsley (*loc. supra cit.*) shows that the following are conditioning circumstances in this consequence of thyroidectomy. (1) The animal in question. Thus, while most severely marked in carnivora, he speaks of the cachexia as moderate, but certain, in man. (2) The age.* (3) The existence of accessory and residual thyroid tissue. (4) The previous state of nutrition, a state of low nutrition before thyroidectomy leading to early and very severe cachexia.

Why this sequence has not been invariable, and what the explanation of it is when it does appear, is as yet uncertain. But, till this matter is cleared up, I am distinctly of opinion that complete extirpation of the thyroid is as yet unjustifiable. It is certainly an operation of many undoubted risks, such as hæmorrhage, injury to the recurrent laryngeal (p. 425) and the trachea, and septic troubles. In addition, the great risk of myxœdema remains, an uncertainty perhaps, but still to be reckoned with. On the other hand, we have operations which are infinitely safer, such as ligature and removal of the isthmus, and removal of one-half, to be followed, if needful, by ligature of the arteries to the opposite half later on.

Operation for Removal of One-half, and the Isthmus as well if required.—I recommend this operation most strongly. I have performed it in 17 cases of ordinary bilateral bronchocele. Of these 15 recovered, 2 died; one a young male, with an enormous and rapidly increasing bronchocele extending behind the sternum, and causing grave dyspnœa. This patient sank within twenty-four hours, and I fear the mediastinal connective tissue was opened up. The other, a woman of forty-four, died without any cause being found, save bronchitis. I am afraid that this case may have, in some way, become septic.

In thirteen out of the fifteen shrinking of the opposite half of the thyroid followed. In two—and it was not till I had operated thirteen times that I became familiar with this possibility—this desired end was only temporarily attained. After a few months the shrinking of the opposite lobe ceased, and it began again to enlarge. In neither of these patients have any troubles—*e.g.*, dyspnœa, &c.—returned, and one has safely borne a child since the operation. I am strongly of opinion that this operation will be found quite sufficient, and very much less risky than total extirpation. In three cases (p. 440) it was performed for a case of exophthalmic goitre. The parts having been cleansed, and the patient's head

* Of Kocher's sixteen cases, in which cachexia strumipriva was developed, nine were under twenty years of age, five between twenty and thirty, and only two above thirty. Eleven were young women; five were males.

and shoulders conveniently supported, the surgeon makes a free incision over the most prominent part of the tumour which he is going to remove, avoiding any large veins. An ample longitudinal incision* will nearly always give all the room that is required, and such a scar will be little conspicuous, falling, as it does eventually, into the sulcus just internal to the sterno-mastoid, a point of much importance in women.

The skin and platysma being cut through, any superficial veins carefully tied, the deep fascia is slit up and the gland itself exposed, bluish-red and with large veins on its surface. Spread also over this are usually one or more of the depressors of the hyoid bone, often much expanded; these are separated with a blunt dissector, or divided, if needful, between chromic gut ligatures. One or more large retractors are now inserted so as to draw outwards the sterno-mastoid and large vessels, while the surgeon with his left index finger, or a blunt dissector, frees the enlarged part of the thyroid from its bed, shelling it forwards, and probably finds it only fixed above, below, and internally, by the thyroid vessels and the isthmus. In effecting this separation, the greatest care must be taken to work gently and to keep close to the tumour,† the veins being often much enlarged and thin-walled.‡ The upper

* The incision can either be made as above, laterally, or it may be angular with a straight limb in the median line from hyoid to sternum, and one passing obliquely outwards and upwards from the upper end of the first. If the surgeon still persists in removing the whole gland, the incision may be Y-shaped. In cases, as in that of Sir W. Mac Cormac (*loc. supra cit.*), where the skin is adherent after the use of setons, &c., the incisions must be made so as to enclose and remove the adherent skin and cicatrices.

† The capsule of the tumour must nowhere be opened. Such a step not only leads to flooding of the wound with blood, but thus also obscures and may lead to damage of important parts—*e.g.*, the recurrent laryngeal and trachea.

‡ While it is quite impossible to give any adequate idea of the number of vessels which may be met with in a large and difficult case, it will be well to recall the principal vein-trunks. The superior thyroid vessels enter at the upper angle; a little below these, emerges laterally a superior accessory vein (Kocher). The same surgeon describes as constant a superior and inferior communicating vein as lying above and below the isthmus, the former joining the two superior thyroids, and the latter entering into the thyroidea ima vein. The inferior thyroid vessels pass behind the outer border of the thyroid, and for some distance behind it, before penetrating it with its several branches. A little above the inferior thyroid vessels emerges the inferior accessory thyroid vein. The anterior jugular will have to be dealt with, and the positions of the internal jugular, and, below, of the innominate veins, will have to be remembered in the case of huge tumours. The above veins are figured by Sir W. Mac Cormac (*loc. supra cit.*) in an illustration taken from Kocher. In a case which Mr. Jessop and Mr. Berry record (*St. Barth. Hosp. Rep.*, 1889, p. 103) the position of the internal jugular was worthy of special notice, lying, as it did, spread out upon the outer side of the left lobe of a large bronchocele. "Instead of bearing the normal relation to the carotid, it lay well in front of and internal to it. Consequently the pulsation of the artery in such cases is not a safe guide to the position of the vein. We wish to lay stress upon this point, since we believe that it is mainly to ignorance of this

extremity of the tumour being first isolated, the superior thyroid vessels are found and tied either with double ligatures of chromic catgut or carbolised silk passed with an aneurism needle, or divided between two pairs of Spencer Wells' forceps, the two ends being tied. This effected, the tumour is next isolated in a downward direction, and any outlying masses turned out from beneath the sterno-mastoid. The next step usually taken is similar isolation, ligature, and division of the inferior thyroids, but I prefer to take the isthmus next, being of opinion that the more the growth is freed and isolated, and the less fixed it is, the more easily are the inferior thyroid vessels dealt with, and the less danger is there of damaging the recurrent laryngeal.

The separation of the isthmus is best effected with a steel director, care being taken to keep the isthmus as much off the trachea as possible, and the point of the director close to the isthmus. Mr. W. Spencer has published a very interesting case (*Ann. of Surg.*, May, 1895), in which the isthmus and trachea were most intimately united, although the thyroid gland seemed the seat of fibroid and not malignant degeneration.

The patient was a young woman with a thyroid normal in size and shape but of marked hardness. The pulse was 130-140. There was no exophthalmos. Stridor was present, loudest at the level of the isthmus. At the operation, no line of demarcation could be made out between the isthmus and the trachea, so the isthmus and the adjacent part of each lateral lobe were shaved away from the trachea, leaving a portion about as large as the end of the thumb. The trachea thus exposed felt like a soft tube and was sucked in and blown out by inspiration and expiration. The cartilaginous rings had softened or disappeared. As the breathing was none the better for the removal of the isthmus, the trachea was opened immediately below the cricoid cartilage. The lumen below this point being seen to be narrowed to a chink, the incision was carried downwards through that part of the trachea which had been in contact with the thyroid, until cartilaginous rings were again met with. In a fortnight the patient was able to discard the tube, and she made a good recovery, though the pulse-rate was still 120 a minute.

When this body has been sufficiently separated, it may be ligatured after transfixion with an aneurism needle carrying carbolised silk or strong chromic gut, or it may be carefully torn through with the point of a director, and each bleeding-point secured.* The amount of hæmorrhage met with in detaching and

altered relation of vein to artery that the not uncommon accident of a wound of the vein during extirpation of the goitre is to be attributed. We believe that the explanation which Lücke gives of this abnormal relation is correct. The common carotid, having no branches, is displaced outwards by the goitre; the jugular, being attached by its branches to the front of the thyroid gland, cannot be displaced to an equal extent, and consequently comes to lie at first in front of, and also internal to, the artery." Whether the above statement that wound of the internal jugular is a "not uncommon accident" in these operations is correct, nay, I think, be doubted, in this country at least. The above case is well worthy of perusal.

* If the pedicle seem too thick and vascular to treat in this way, which may be the case in colossal bronchoceles, it should be subdivided and tied in several

dividing the isthmus varies. If the separating is effected piecemeal, the bleeding is often very slight. This is probably accounted for by the fact that the intimacy of connection and continuity of structure between the halves of the thyroid and the isthmus varies much also; in many cases the connection is mainly by connective and a little glandular tissue, with very few vessels.

The tumour, now almost completely isolated, is drawn to one side, and especial care is taken before ligaturing the inferior thyroid vessels. These should be most carefully isolated and inspected, so as to avoid injury to, or including, the recurrent laryngeal. Owing to the fact that the trunk of the inferior thyroid artery does not come into relation with the recurrent laryngeal till both are close to the trachea, either the trunk of the vessel should be ligatured and cut at some distance from this tube, or its branches tied close to the gland.

If the vessel is tied near the junction of cricoid and trachea, the nerve may very likely be included, and the same risk is run if at this stage especially, the wound is not kept dry and bloodless.

After the removal of the tumour, the wound should be examined for any bleeding points, adequate drainage then provided, and the wound carefully closed, save below, to allow of free escape of discharges here, and thus to avoid any risk of burrowing, and mediastinal cellulitis.

If during the operation there is any evidence of syncope, the head should be lowered and injections of ether or brandy given. Both the surgeon and the assistant who is giving the anæsthetic must be on the look-out for evidence of dyspnoea or asphyxia. If any sign of these occur, it is an indication for the surgeon most carefully to examine the tissues which he is handling, and the amount to which he may be dragging upon the air-passages in the manipulation of the tumour. Tracheotomy seems to be nearly always a fatal complication,* partly by rendering such a deep and important wound septic, partly by causing septic bronchopneumonia, and partly by adding to the shock in a patient already collapsed by so severe an operation.

If tracheotomy appear urgently needed, the surgeon should try first slitting up more freely the deep cervical fascia or dividing any stretched muscles, in order to relieve the trachea and breathing.

In the event of the operation having to be performed, great

pieces, like a stout ovarian pedicle, the ligatures being made to interlock. If this cannot be managed, and if the patient's condition admits of it, the pedicle may be slowly divided by an *écraseur*, or seared through with the cautery. In such case the stump should be brushed over with a solution of zinc chloride, gr. x-5j, packed round with iodoform gauze wrung out of carbolic acid lotion (1-20) and brought outside the wound.

* In five of Billroth's cases in which tracheotomy was performed three died. Kocher's experience has been the same.

difficulties must be expected, and the surgeon should be provided with long soft tubes, in case there is any mediastinal prolongation pressing upon the lower part of the trachea. Every possible attention must be paid to keeping the tracheotomy wound sweet with applications of iodoform, iodoform and ether, &c. Sir W. Mac Cormac mentions the need of keeping the head very steady during the tracheotomy, and, later on, with sand-bags; he advises leaving the thyroidectomy wound open and treating it with frequent irrigation, if tracheotomy has been found necessary. Irrigation with mercury perchloride (1 in 4000) should be used at intervals throughout. The wound left after removal of one enlarged lobe only, is often vast and deep, the larynx, trachea, œsophagus, and common carotid being all exposed. In two of my cases the dome of the pleura has been exposed, rising and falling in the root of the neck. The wound is a difficult one to drain satisfactorily, from its lower portion dipping behind the sternum. In order to obviate any collection of fluid, before the wound is brought together, all irrigating fluid, blood clots, &c., should be most thoroughly dried out, a sponge should be kept in the wound while the sutures are inserted; a little iodoform is then carefully dusted into all the recesses of the wound. Two drainage-tubes may be made use of, one from the deepest part of the wound to its lower angle, and one through the whole length of the wound; but if the operation has been aseptic throughout, and the wound thoroughly dried out, they are not essential. When much disturbance of the parts laterally has been needful, and in one of my cases the common carotid was displaced into the posterior triangle, it will be well to pass a tube laterally by counter-puncture, avoiding the jugular veins. A small, narrow sponge is inserted while the sutures are put in. I prefer fishing-gut and horsehair carefully rendered aseptic; the former are passed through the whole thickness of each lip of the wound, and at some distance from it. When the sutures are all in place, the sponge is withdrawn before they are tied. The edges of the wound should be brought into most exact apposition, to promote sound healing. I have observed a distinct tendency for the scar to become keloid; this condition is, however, only a temporary one. When all the sutures are tied, the wound is again irrigated and insufflated, and strips of iodoform gauze, wrung out of carbolic acid lotion (1 in 20), applied over green protective. Over these some sal alembroth wool is placed, and then the gauze bandages, so as to get firm, even pressure, distributing the discharges evenly through the dressings. The patient should be kept propped up in bed, and his head well steadied with sand-bags.

For the first few days after thyroidectomy, care must be taken to keep the dressings securely in position. This is especially difficult in a mobile part like the neck, which does not admit of compression. The safest plan is to pass the gauze bandages under the axillæ below, and, above, to wind them over the chin and

forehead, points of friction being carefully packed with aseptic wool, and all made secure by stitching. This alone will keep the dressings from slipping down.

Unless primary union is secured throughout, any silk ligatures used are liable to come away for many months.

Thus, Sir W. Mac Cormac (*l.s.c.*) relates a thyroidectomy lasting two hours, in which at least a hundred ligatures were used. Six months later a sinus was still discharging ligature-threads (*vide infra*, p. 446).

Enucleation of Thyroid Adenomata.—This method has been largely used by Porta, Billroth, Socin, Reverdin, Woelfler, and other continental surgeons. Mr. Symonds (*Clin. Soc. Trans.*, vol. xxiii. p. 51), following on the same lines, has shown that, in cases of ordinary solid enlargement of the thyroid, encapsuled adenomata are often present, and that it is sufficient and a much less severe operation to enucleate these instead of removing one half of the gland. In practising enucleation it is necessary, when the enlarged lobe has been exposed and brought well up into the wound, to search for and define most accurately the capsule of the adenoma. "In most cases it will be seen at once, but in a few the edge of the gland may have to be raised first. It is most essential to be sure that the smooth, white covering is exposed; for, if not, and the dissection be carried outside it, troublesome hæmorrhage is sure to follow: in fact, the entire success turns upon this point." Any surgeon adopting this method will remember (1) the above danger, a very present one, of hæmorrhage;* (2) the fact that these adenomata may be multiple,† and that if one be left behind it will keep up the enlargement of the lobe; (3) that shrinking of the opposite lobe, which it is our aim to bring about by removing one lobe, is not so likely to follow on removal of an adenoma as it is when one lobe and half the isthmus have been removed; (4) enucleation is not applicable to all cases, *e.g.*, the gelatinous form of adenoma.

Treatment of Enlarged Thyroid by Operations on the Isthmus.—This method consists in excising the isthmus after applying double ligatures, or in trusting to double ligatures alone. It was first recommended in this country by Sir D. Gibb (*Lancet*, 1875, vol. i. p. 120), and more recently by Mr. Sydney Jones.

In Sir D. Gibb's cases the patients were young women whose bronchoceles had resisted other treatment. In one case there was general enlargement of the thyroid, especially on the right side, the isthmus could be felt, distinctly rounded, and projecting somewhat over the trachea. Mr. Holthouse exposed the isthmus.

* Woelfler, in his exhaustive monograph (Berlin: A. Hirshwald, 1891), shows that while this method was successful in the great majority of cases, it has proved fatal from hæmorrhage.

† Woelfler (*loc. supra cit.*) mentions a case in which as many as thirty or forty adenomata were present. He states that recurrence took place in one case after this method had been employed, but that as most of the cases are too recent, nothing definite can be stated on this point.

and after placing a ligature on either side, removed it. About six months later the patient was entirely free from her old symptoms—tension, dyspnœa, &c.—and the lobes appeared to have receded laterally, and to be less prominent.

In the second case there was much enlargement of the veins owing to extension downwards of the bronchocele. Cough, dysphagia, and, at times, urgent dyspnœa were present. When Mr. Holthouse exposed the isthmus it suddenly cropped up like a hernial tumour. After cautiously detaching it with curved scissors, two ligatures were passed under it as widely apart as possible. As they seemed likely to become detached if the isthmus was cut away, they were left in to slough out. The patient made a good recovery, with much relief to her symptoms.

Mr. Sydney Jones has recorded (*Lancet*, November 24, 1883) the case of a patient, aged eighteen, who had noticed the swelling about eight years; latterly it had increased rapidly. The dyspnœa was marked, the least exertion bringing on paroxysms. The thyroid was greatly enlarged, the right lobe being much the larger, while the isthmus could be traced extending below its usual position, as a band about 1 inch in vertical measurement. An incision about $3\frac{1}{2}$ inches long being made in the middle line, transverse branches of the anterior jugular vein being tied and turned aside, the isthmus was detached by the finger and director from the front of the trachea. An aneurism needle was then made to perforate, which it did easily, the junction of the isthmus with each lateral lobe. The double ligature on each side was tied as with an ovarian pedicle, and the isthmus cut away. There was very little hæmorrhage. The trachea was very much compressed, of triangular shape, with the apex forwards, and each lateral surface somewhat concave. Immediately on removal of the isthmus much relief seemed to be afforded to the patient. The dyspnœa quickly ceased, and when the patient left, in less than two months, the thyroid could not be felt.

I have followed Mr. Sydney Jones in three cases, with a good result, the shrinking of the lateral lobes being steady and progressive. I cannot, however, say whether this has been permanent, and as in two cases in which I had removed one lateral lobe as well as the isthmus, the other lobe which had shrunk out of sight, began two and three years later to enlarge again, I have ceased to practise removal of the isthmus alone. But where dyspnœa is increasing, and slitting up of the deep fascia freely does not relieve it, and in cases where the surgeon is short-handed, a trial of this method would be quite justifiable.

A trial of this operation would be also justified in the following cases: When the isthmus is distinctly enlarged in (a) cases of colossal growths where the surgeon does not care to undertake more; * (β) where, owing to the anæsthetic being not well taken, the time for operation is limited; (γ) where, the lateral lobes being little affected, the isthmus is the seat of the enlargement, especially if tracheal stridor be present. If with general enlargement dyspnœa is present, removal of one of the lateral lobes as well as the isthmus gives much more speedy and decided relief. I accordingly prefer the latter operation wherever the lateral lobes are much enlarged. The isthmus can be raised without difficulty with a steel director or blunt dissector from the trachea, it is then transfixed at its junction with the lateral lobes, or through these themselves, with a double sulphuro-chromic gut

* In these cases the shrinking of the lateral lobes may be slow.

ligature (this should be tested beforehand). The ligatures being tied, the gland-tissue is snipped through between them, the isthmus removed, and the stumps pared away as close to the remaining ligatures as is safe.

Thyroidectomy for Exophthalmic Goitre.—I have operated in three of these cases, all in young women. The first alone has been operated on sufficiently long ago to be of any value. She was a patient, aged twenty-two, of Dr. Garrard of Rickmansworth. I operated by the advice of Dr. Goodhart.

Proptosis had been noticed for three years, but the enlargement of the thyroid for only six months. Both lobes, especially the right, and the isthmus were much enlarged, the latter extending down to the sternum. The whole gland was spongy, and pulsated slightly, in addition to receiving pulsation from the carotids. A marked thrill could be felt over it. A venous bruit could be heard at the lower part of the right lobe, a systolic bruit over the pulmonary, and one much less marked over the aortic area. Slight attacks of dyspnoea had recently appeared, especially at night, "with wheezing." There was occasionally some difficulty in swallowing. Chloroform was taken quietly. An incision, about 7 in. long, being made from behind the right angle of the jaw to the left sterno-clavicular joint, the tumour was exposed by slitting up the deep fascia and partly dividing, partly retracting, the hyoid depressors. The three parts of the thyroid were intimately fused, thick, and fleshy; the isthmus had crept down to the manubrium. A very striking feature was five or six huge veins, the size of the axillary, coursing over the front of the tumour to dip down behind the sternum. The thyroid vessels on the right side were first found and tied, the inferior being dealt with by tying its branches very close to the gland, so as to avoid the recurrent laryngeal nerve. The right lobe was then dissected from the trachea with a steel director, the adhesions being intimately close by firm connective tissue not very vascular. The large veins already mentioned having been secured with double sulphuro-chromic gut ligatures, the isthmus was next freed from the trachea and its junction with the left lobe carefully transfixed with a steel director. Along the director an aneurism needle loaded with stout gut was passed. The loop of this was drawn through and cut, and the two halves of the above junction tied tightly. The right lobe and the isthmus were then cut away. Recovery was most satisfactory, the patient being up on the eleventh day. There was still some throbbing over the left side, but this was no longer perceptible to the patient. The basic bruits had disappeared. This case, which has now been operated on nearly three years ago, was for some time most successful. Two years afterwards she reported as follows: "I am much better, the swelling in my neck is scarcely to be seen. The palpitations are better, and my eyes not so prominent. I can walk over ten miles without feeling tired, and take my food well. I work at the machine from 8 A.M. till 8 P.M., dressmaking." But about three months later on nine months ago she appeared with a return of the swelling on the left side, eyeballs as prominent as before, shortness of breath, and palpitation of the heart. Since this time I have not seen her. The failure in this case, if it prove to be a failure, is largely due to the unhealthy conditions under which the patient lives. The second patient was under the care of my colleague, Dr. Wheaton, at the Royal Hospital for Children and Women. She made a good recovery from the operation, which took place a year ago, with distinct relief to the palpitations and exophthalmos, but I have not been able to learn the result. The third was a lady, aged thirty-three, a patient of Dr. A. E. Taylor of Acton, whom I saw in May 1894. Here the palpitation, shortness of breath, throbbing of the carotids, dated to an attack of influenza about six months before, viz., Dec. 1894. Proptosis and the goitre followed. Dr. Taylor reported "a systolic

murmur over apex and pulmonary area, with marked pulsation of carotids. Heart not hypertrophied. The murmur also heard over the goitre, and distinct thrill felt here. One marked symptom, nervousness, excitability, fidgetiness, with great irritability and nervous cough. Pulse-rate 130-140. Respirations 120. Temperature subnormal. Urine normal." The enlargement of the thyroid had been rapid, the patient having in April to let out the collars of her dresses 2 inches. Treatment having failed, I operated June 28, removing the right lobe, which was distinctly the larger of the two. The only trouble was with the isthmus, which was large and lobulated. This was peeled off from the trachea up to its junction with the left lobe, transfixed with two sterilised silk interlocking ligatures, and cut away, the stump being pared down to within safe distance of the ligatures. A.C.E. and ether were well taken. Here, as in the second case, nervousness and excitability had been very marked features, and in each case the restlessness after the operation was extreme for the first thirty-six hours. In spite of this the wound was healed in eight days. A month later the diminution in the thyroid was very marked, and the patient expressed herself as much better. Her friends said that cheerfulness had taken the place of her nervousness. The proptosis, however, was but slightly lessened, and the pulse still 100.

July 18, 1895, Dr. Taylor kindly reports: "Proptosis less marked. Pulse-rate 100, patient being flurried. Patient could skate in the winter and can now walk ordinary distances. Breathlessness better and palpitation less. General appearance healthy."

Removal of half or the whole of the thyroid gland has been practised in a large number of cases in Germany.* The cases show such a proportion of success as to justify resort to surgery in certain cases (*vide infra*). On the one hand, it is clear that removal of one half of the isthmus is often followed by rapid (within a few days) relief to the exophthalmos, palpitations, and pulse rate. On the other, many of the cases published as cases of cure are quite unreliable. Thus Lenke (*loc. supra cit.*), who holds that all cases of Morbus Basedowii are surgical, not medical, relies upon two successful cases published six and seven months after the operation. Again, the fragility of the capsule and of the vessels must be remembered in operations for this disease, and it will always be necessary to exercise the utmost caution with the anæsthetic, owing to possible conditions of the heart and large vessels.

Indications.—I think that partial excision is especially called for in those cases of exophthalmic goitre where previous treatment has failed; in the rarer cases where dyspnœa is present or ulceration of the corneæ threatening, and where those distressing nervous symptoms, perhaps pointing to a toxic state of the nerve centres, are present, as in my second and third cases. Owing to the tendency to cardiac syncope in these cases the operation should not be deferred too long.

Question of Operation in Cases of Malignant Disease of the Thyroid.—The surgeon must consider here most carefully whether any operation is justifiable. In the first place the risk of injury to the recurrent laryngeal is much increased

* Mannheim (*Morbus Gravesii*, Berlin, 1894), Wette (*Langenbeck's Arch. f. Clin. Chir.*, Bd. xliv. pp. 785, 805), Lemke (*Deuts. Med. Woch.*, 1891), Hack (*ibid.*, 1886), Rehn (*Berlin Klin. Woch.*, 1884).

from the tendency of a malignant growth to creep round the trachea, dip into the sulci between the large vessels and the windpipe, and to infiltrate important parts. Secondly, these growths, especially if rapid, tend to creep down into the anterior mediastinum,* behind the sternum. Thirdly, in addition to these dangers, must be considered that of glandular invasion—*e.g.*, cervical, mediastinal, bronchial—and the doubtfulness of getting all the growth away, and the increased risks of hæmorrhage and cellulitis.

Mr. Sydney Jones and Mr. Battle have published (*St. Thomas's Hosp. Rep.*, vol. xvii. p. 232) an interesting case of sarcoma of the thyroid. The malignancy probably supervened upon previous ordinary enlargement of the gland. It was operated on repeatedly, for the first time very extensively, one sterno-mastoid being divided, July 16, 1887. A second operation, November 2, found both the sheath of the carotid and the œsophagus involved. Two months later, tracheotomy was required owing to fresh recurrence. Two further operations were performed in the next three months, and the tracheotomy tube now not proving long enough, the useful device of securing a piece of large drainage-tube to a full-sized Durham's cannula made the patient comfortable. A little later, April 5, 1888, severe hæmorrhage took place from the common carotid, and two ligatures were applied above and below an opening in this vessel. The patient sank two days after, some dyspnoea having returned at the last. Notwithstanding the rapid recurrence, life was prolonged with comfort by the repeated operations for some months. In the fact that "the local malignancy was great, the general malignancy *nil*," this case of sarcoma contrasts strongly with the much more common carcinoma.

Dr. Rotter (*Arch. f. Clin. Chir.*, Bd. xxxi. Heft 4; *Year-Book of Treatment*, 1885, p. 138) gives details of fifty cases of cancer of the thyroid submitted to operation. Of these eight died in the first twenty-four hours, five at the end of the first week, and eight at the end of the second week. Only four patients remained free from a recurrence at the end of six months. These figures point very strongly to the conclusion that in malignant disease of the thyroid attempted removal is most rarely justifiable.

Mr. Butlin (*Operat. Treat. of Malig. Dis.*, p. 206) thinks that "at present the number of instances in which a cure of the disease can be claimed is so small† that the operation is scarcely justi-

* A remarkable instance of malignant bronchocele is figured by Billroth (*Clin. Surg.*, pl. ii. and iii). It was a soft carcinoma, and extended down behind the sternum, compressing the right innominate vein, and causing enormous dilatation of the superficial veins of the neck and front of the trunk.

† He thus analyses the cases in the paper by Dr. Rotter, quoted above, and two others by Dr. Rose and Dr. Braun (*Langenbeck's Arch.*, 1879, 1883). Of fifty cases submitted to operation thirty were fatal. Of the twenty which survived the operation, a recurrence took place in ten, which was either fatal or promised rapidly to be so. In two the operation was abandoned. In three the further history was not known, and in one it only extended to a period of two months after the operation. In four only was a result, which Mr. Butlin courteously calls favourable, obtained. One, a patient of Bircher's, was well eleven months after operation. In the second, Bruns removed some enlarged glands a year after the first operation, and two and a quarter years later the patient died of inflammation

fied." The following facts, to which Mr. Butlin draws attention, are worthy of careful notice: (1) The large number of cases in which secondary affection was discovered at the autopsy, even when death occurred within a few days after the operation; (2) The frequency with which it was found impossible to entirely remove the tumour; (3) The difficulty of diagnosis in the early stage of malignant disease of the thyroid. The chief points which should be looked to here are early fixity and irregularity of outline, to which Mr. Butlin, quoting from Rose, adds continuous growth* and marked dysphagia.

Treatment of Enlarged Thyroid by Ligature of the Arteries. This operation was performed in 31 known cases (Woelfler, *loc. infra cit.*), but was given up, (1) from deaths due to wound-treatment of former days, (2) from imperfect results, as the inferior thyroid was never ligatured at the same time.

Prof. Woelfler,† now of Graz, considering that the various methods of treating goitre are still open to objections, has lately advocated a trial of the above method.

In October 1885 he made use of it in a patient aged twenty-nine, who had much dyspnœa from a rather large colloid thyroid; the right half being somewhat the larger, both the thyroid arteries were tied on this side, and also the median thyroid vein. The patient was discharged nine days later, the dyspnœa being considerably relieved and gradually subsiding completely. The neck, however, did not diminish in size at the same rate. A week after the operation the median circumference had diminished 1 cm., and seven months later 6 cm., when the right side of the goitre had shrank to one-half its former size; the left side had diminished somewhat.

Prof. Woelfler, from his later experience,‡ shows (1) that considerable shrinking, marked relief to dyspnœa, should follow this method, if successful, in a few days, and that there should be no recurrence. (2) Splendid results are here opposed by utter failures. If in the latter cases all the four arteries have been tied, abnormal vessels have perhaps existed. On this point he quotes Billroth as to whether the atrophy will be permanent: "If all four arteries have been tied, *yes*; if the circulation is re-established either through one of the principal arteries or through the vasa

of the lungs. The third, a patient of Maas', was reported to be quite well nearly four years after the operation; and the fourth, under the same surgeon, died in twelve months of some uncertain lung affection.

* Rose has pointed out that the surgeon is liable to be deceived on this point by the effect of remedies. Thus, potassium iodide may cause a diminution in the size of the neck, a fact which may be attributed to the effect of the drug on the general enlargement of the gland, which is frequently associated with the occurrence of more or less limited malignant disease. Attention has already been drawn at p. 362 of this book to the procrastination (sometimes pernicious in its results) which this temporary result of giving potassium iodide may bring about in malignant disease.

† *Wien. Med. Woch.*, 1886, Nos. 29 and 30; *Ann. of Surg.*, December 1886, p. 523.

‡ In his monograph on the Surgical Treatment of Goitre (*loc. supra cit.*) p. 438.

vasorum, *no.*" (3) Experience has shown that ligature of all the four arteries is not followed by gangrene of the thyroid.

A further trial of this method is justifiable in any vascular and rapidly growing bronchoceles, especially if inclining to gelatinous consistency. Other indications are those rare cases in which an especial danger is present from paralysis of one vocal cord, or where extirpation of one-half is thought unadvisable on account of the age, or some special point in the condition of the patient.

These vessels vary so much in situation and course, according to the size and growth of the bronchoceles in different directions, that any dissections for finding them must be uncertain. The chief points to bear in mind are the upper and lower parts of the enlarged lobe: the superior thyroid artery is often rendered superficial by the upper limit of the tumour raising it up. Both vessels may be enlarged and somewhat softened, and thus secondary hæmorrhage may readily occur unless the wound is kept sweet.

Ligature of Superior Thyroid Artery.

RELATIONS.—This vessel, the first branch of the external carotid, arises just above the bifurcation, about a quarter of an inch below the great cornu of the hyoid. At first, covered only by thin fasciæ and the platysma, it ascends slightly, and then curves downwards with a tortuous course, covered by the depressors of the hyoid bone and the sterno-thyroid.

Operation.—The patient's head being suitably raised, and turned to the opposite side, an incision, about 2 inches long, is made along the inner border of the sterno-mastoid, with its centre corresponding to the upper border of the thyroid cartilage. The superficial parts being divided, the sterno-mastoid and the large vessels are drawn outwards, and the omo-hyoid downwards and inwards, or else tied and divided. The artery is then searched for with the point of a steel director in the hollow between the larynx and the carotid. Some enlarged veins, belonging to the superior thyroid, will probably require division after the application of double chromic gut ligatures.

Ligature of Inferior Thyroid Artery.—This operation is a good deal more difficult, owing to the depth of the vessel and its more important relations.

RELATIONS.—The artery, the largest branch of the thyroid axis, ascends tortuously inwards behind the carotid sheath, the middle cervical ganglion and its branches lying in front of it. Before entering the gland it lies for a little distance in relation with its posterior surface, and in this part of its course the recurrent laryngeal is in close contact with it.*

* Sir W. Mac Cormac (*Lig. of Arteries*, p. 71) says that the nerve often passes between the terminal branches of the artery. He reminds the operator that the left artery is in close contact with the œsophagus, and that the thoracic duct, at first posterior, arches over the artery on this side to enter the left subclavian vein.

GUIDE.—The carotid tubercle of Chassaignac, or the transverse process of the sixth cervical vertebra. Sir W. Mac Cormac gives the body of the fifth cervical vertebra, opposite to which the artery enters the thyroid gland. The common carotid is also a guide.

Operation.—An incision, 3 inches long, being made along the anterior border of the sterno-mastoid coming down to the clavicle, as if for ligature of the carotid low down, the deep fascia is opened and the sterno-mastoid and the structures in the carotid sheath drawn outwards. The head being now flexed to relax the parts, the carotid tubercle is felt for, and the artery sought for below it, by carefully working here with a director. The vessel should be exposed and the ligature applied* as close to the carotid as possible, and thus at some distance from the thyroid gland, so as to avoid injury to the recurrent laryngeal, which, as above stated, crosses over the trunk or ascends among the branches of the inferior thyroid. The neighbourhood of other important structures—*e.g.*, the phrenic nerve, must be remembered.

Treatment of Thyroid Cysts (Fig. 131).—These are sometimes of much importance owing to their size, their important relations, and, as shown by Mr. Clutton's case below, by their occasional vascularity.

The best treatment is antiseptic excision whenever this is practicable; with much larger and older ones, a safer one may be antiseptic incision and drainage. Injection with iron perchloride has given some good results, but there is always the risk of suppuration and cellulitis in a very dangerous region owing to the presence of the larynx above, the mediastinum below, and of numerous veins, these being liable to puncture, and thus to immediately fatal thrombosis, or, later on, to septic phlebitis.

Where the cyst is moderate in size and not of very long duration, it should always be excised, and the case given below shows that this may sometimes be practised where the cyst is huge in size and of long duration. The cyst, if not previously submitted to futile blistering, &c., usually turns out easily. If it will give more room the cyst may be slit up, its contents evacuated, and then, by seizing first one cut edge and then the other, it is turned out in a collapsed and empty state. In either case, great care must be taken to work most closely to the cyst wall.

The above remarks apply to single cysts. Mr. Clutton (*St. Thomas's Hosp. Repts.*, vol. xvi. p. 173) has pointed out that where there are many cysts, or where a cyst is combined with much disease, the whole half of the thyroid affected had better be removed.

The method of incision usually involves a very simple operation. The soft parts having been duly cleansed, an incision is made through them down to the cyst, and any bleeding points

* According to Billroth and Woëlfler this artery is often friable, and thus easily torn, this condition being perhaps due to fatty degeneration due to pressure of the bronchocele.

secured. The cyst is then slit open and its interior examined. This may vary considerably both as to thickness and contents, and vascularity of lining membrane. Thus the contents may be a serous, mucoid, gelatinous, or grumous material, or coagulated blood-clot. The amount of vascularity is of twofold importance: if of very long standing the cyst-wall may be so fibrous and evascular that sloughing of it may readily take place, especially if the wound becomes septic. On the other hand, it may be extremely vascular (Clutton, *loc. supra cit.*), in which case such abundant hæmorrhage will take place as to leave no time for suturing, and require immediate plugging with aseptic gauze.

Knowing how tedious these cases are in granulating from the bottom and becoming completely obliterated, I prefer to suture the cut edge of the cyst to the surrounding margin of the skin, and then, with a sharp spoon, to scrape over the lining membrane, thus promoting the closing of the cavity from the bottom. A drainage-tube is then inserted, the cavity plugged with strips of gauze, and the dressings applied. But this method, by failing to secure primary union, is much more tedious than that of excision.

I would again draw attention to the very important fact that in these, as in all other thyroid cases (and in many others) where primary union is not secured, silk ligatures, if many of these have been used, may continue to come away for a very prolonged period. The cyst quickly falls in and puckers together, but a sinus is liable to persist through which ligatures are long discharged. Thus, in one of Mr. Clutton's cases a sinus persisted for two years, and then quickly closed; in another the patient was still wearing a drainage-tube a year after the operation. And in the case of mine now mentioned, it was not till nine months after the operation that the last ligature came away, and the wound soundly closed.*

As bearing on the treatment of thyroid cysts by excision, and as a good example of one of the complications which may follow operations on the thyroid gland, I may now mention the following case (Fig. 131):

A gentleman, aged fifty-five, was sent to me, towards the close of 1885, by Mr. Cooper Forster, with a right-sided thyroid cyst, almost colossal in size, and reaching from the ear to below the clavicle, and outwards, into the posterior triangle. The trachea was under the edge of the left sterno-mastoid. The swelling was first noticed twenty-six years before, being then about the size of a hazel-nut. About nineteen years before, owing to some dyspnoea, the swelling was tapped by Mr. Forster; gradually refilling and increasing in size, it was tapped by myself in 1885, the fluid being thick with material resembling Parmesan

* In this case plaited-twist silk (Turner's) was used. This is so closely interwoven as to resist changes in the tissues and absorption most obstinately. I have been much disappointed at the way in which it keeps a sinus persistent and comes away long after such operations as radical cure of hernia, nephrorraphy, and nephrectomy. For buried sutures or ligatures ordinary silk of appropriate thickness is much to be preferred, being equally safe and of a much more open texture.

cheese. As the cyst quickly refilled, I proposed free incision and drainage, and sought first the opinion of my colleague, Mr. Durham. As in spite of twenty-six years' history the cyst had a certain distinct, though limited amount of mobility, Mr. Durham advised extirpation in preference to incision. This counsel I accordingly followed. Ether was taken very badly, especially at first. An incision being made from the angle of the jaw to the right sterno-clavicular articulation, the sterno-mastoid was found spread out over the cyst and adherent to it, perhaps from the previous tappings. As the patient was breathing very badly, no time was spent in separating the muscle, but the cyst was reached by cutting away the adherent part. The superior thyroids being found and tied, the cyst was turned downwards out of its bed, partly with the finger, partly with a blunt dissector; a vessel in the position of the middle thyroid vein was found, and a small vessel below where the inferior thyroid was expected. The chief

FIG. 131.



attachment of the cyst was in the middle line, where it was connected with the isthmus (not itself enlarged) by a fairly fleshy pedicle. This was separated from the trachea and tied in three pieces, partly with the aid of a steel director, partly with an aneurism needle. About fourteen carbolised silk ligatures were used, and strict antiseptic precautions were taken throughout, including the use of the spray. An enormous cavity remained when the cyst was shelled out, exposing the common carotid and its bifurcation, the larynx and trachea, but though a strong light was thrown into the bottom with a mirror, nothing could be seen of the oesophagus or recurrent laryngeal. Special care was taken to verify this, as towards the close of the operation (which lasted twenty-five minutes) there was some vomiting of coffee-grounds stuff, streaked here and there with brightish blood.

No dyspnoea and no lividity had been noticed during the operation, beyond

the difficulty which had from the first accompanied the anæsthetic. As the effects of the ether subsided, a peculiar stridor was found to accompany the breathing, being much more marked in inspiration. The voice was not affected, beyond being weak, and there was no lividity. The stridor, but without marked dyspnœa, went on increasing for about two hours, the patient being much alarmed from dreaded "choking." Though he vowed that he could not swallow owing to the above alarm and from the feeling of soreness, "like a bone in the throat," he was persuaded to take a dose of potassium bromide, and passed a fairly good night. The next day was a comfortable one, and the breathing, which was twenty in the minute, was much easier, and perfectly so while the patient slept. The next two days were very anxious ones, the stridor returning, with great restlessness and distress, on account of paroxysmal attacks of dyspnœa. Accompanying these a condition of quiet delirium set in. The respirations ran up to 40, the pulse to 140, while the temperature remained 99°. The wound was now, and throughout, perfectly sweet. As there was some carboloria (without albumen), the drainage-tubes were syringed out with boracic acid, and iodoform gauze dressings applied as before.

The pulse was of grave omen, about every ten or twelve beats dropping, fluttering, and then, as it were, staggering on, to intermit again in another ten beats. This, Dr. Goodhart thought, might be due to some chloral that had been given at night.

The diagnosis now was doubtful—whether one of injury to the recurrent laryngeal, or one of œdema glottidis. Mr. Durham, who inclined to the latter view, advised the use of warm, moist, boracic acid lint-dressings, and inhalations of steam and terebene.

The breathing gradually became less laborious and noisy, and the power of swallowing quickly returned. Recovery was retarded by a succession of fogs and some localised pneumonia, which, giving anxiety at first, entirely cleared up under Dr. Goodhart's hands. When the patient left town, six weeks after the operation, there was no difficulty in swallowing, the stridor was only noticed on deep respiration, or during quick or prolonged talking. The wound was now represented by a sinus at the lower end; all the rest was well healed. Ligatures continued to come away for nine months, when the wound healed at once. When the patient was last seen, four years after the operation, there was still a very little stridor on deep breathing or rapid talking, and the voice was still a little husky, but the patient was able to follow his employment actively and to get quickly over hilly ground.*

While the diagnosis here remains obscure,† I am of opinion that, with the bloody vomit in the course of the operation, and the great dysphagia afterwards, although the huge cyst turned out so quickly, some slight injury was inflicted on the œsophagus, with stretching or imbedding in inflammatory effusion of the right recurrent laryngeal. Whether this is right or not, I think, with all proper deference to Mr. Durham's opinion, that this case shows that, in cases of thyroid cysts, when large or of long standing, incision with antiseptic precautions is preferable to excision.

* A year after the operation he wrote thus: "I have not been so strong and active for many years. The other day I went in the morning to London, to the Academy, Grosvenor, 'Alice in Wonderland,' Fitzroy House, then to a council-meeting of the Photographic Society, and home. There was a damp fog all day, and I am not the worse for it."

† Owing to a projection of the incisor teeth, and a life-long difficulty in opening the mouth widely, it was found impossible—Mr. Durham and Dr. Goodhart also trying—to get a view of this patient's larynx.

CHAPTER XIV.

REMOVAL OF LARGE DEEP-SEATED GROWTHS IN THE NECK.

BEFORE deciding to undertake the removal of one of these, the surgeon should consider carefully the following points :

A. The nature and surroundings of the growth.

B. His operative skill in these cases, and his knowledge of anatomy.

C. His experience in antiseptic surgery and in keeping a large wound aseptic.

The chief growths which call for a decision are the following: The rarely met with more innocent ones—*e.g.*, the enchondroma of Prof. Spence,* the fibrous tumour of Mr. Butcher,† glandular tumours, including the more simple tubercular glands when they do not yield to other treatment; sarcomata, very likely cystic, originating in the neck apart from the cervical glands; sarcomata of the glands; and carcinomata of the glands secondary to epithelioma of the tongue, lip, &c.

Of the three points above mentioned, it will only be needful to consider separately the first; the importance of the two others will be sufficiently shown in the remarks on the operation and after-treatment.

A. The Nature and Surroundings of the Growth.‡—In examining into these, careful attention should be paid to the following: *Duration. Rate of increase. Amount of fixity.* How far this last was early established, and how far it is absolute, is of the utmost importance. The gravest cause of fixity is, of

* Growths of the tonsil are considered at p. 377; bronchocele at p. 425.

† This case, in which the growth weighed over 7 lbs., is related in the *Dub. Journ. Med. Sci.*, November 1863. Mr. Butcher's case will be found amongst his *Operative Surgery Essays*, p. 809. The reader should also consult Mr. Holmes' remarks on these cases (*Syst. of Surg.*, vol. viii. p. 886), a paper by Mr. Barker (*Lancet*, 1886, vol. i. p. 194), and one by Mr. Jessett, illustrated by some admirable photographs (*Brit. Med. Journ.*, 1886, vol. ii. p. 712).

‡ Mr. Holmes (*loc. supra cit.*) quotes Langenbeck (*Arch. f. Klin. Chir.*, Bd. i. Hft. 4, S. 14) as pointing out that, in tumours which involve the sheath of the vessels, engorgement of the veins of the face is rarely absent. In one case he observed this venous engorgement to be on the opposite side to the tumour. This he attributed to the fact that the tumour compressed the carotid artery as well as the jugular vein, as proved by the weakness of the temporal pulse.

course, a growth with a wide base, or numerous root-like processes extending into important parts. The fixity should be tested by seeing how far the finger-tips can be insinuated beneath the growth, how far it can be lifted up, and the amount of its connection to parts such as the jaw and larynx, the head being steadied by an assistant while the growth is lifted up and its deep processes put on the stretch as much as possible. *The outline.* Is this well marked or indistinct, and, if the latter, is it in dangerous regions such as the parotid, the zygomatic, and other fossæ, that the growth is lost? *Its relation to important structures, and the degree to which it blends with them.* Thus, any evidence of pressure on vessels and nerves, trachea and pharynx, &c., should be carefully looked for—*e.g.*, weakness of temporal pulse, engorgement of veins above, alteration of pupil, numbness of upper limb, dyspnœa, or dysphagia. Does the growth dip near or into the thorax? How far under the sterno-mastoid does it go? Are the glands enlarged as well? Is the skin involved? This last point, together with fixity, indistinctness of outline, rapid growth, softness, and fusion with surrounding parts, are of chief importance, and, if co-existing to any extent, will usually put any operation out of the question.

Even when the surgeon is doubtful as to the advisability of meddling with one of these growths, he may decide to make an attempt under the following circumstances, even if it end in failure:

When the patient's life is rendered worthless by the present wretchedness and approaching dangers of the growth, especially if he be young, as in the words of Mr. Butcher (*loc. supra cit.*, p. 871):

Though the boy did not suffer pain, yet his life was rendered very miserable . . . the weight ever tending to depress the head, occasioning persistent fatigue and even pain in the muscles of the neck, and so compelling the patient often to adopt the recumbent position, the bulk thrusting up the head, embarrassing every movement, almost preventing any change of position; the pressure impeding respiration, often obstructing it during sleep so as momentarily to threaten suffocation, making the patient start from his bed in terror and alarm, unrelenting or enforcing one attitude during sleep, with difficulty in deglutition except under extreme watchfulness in adopting position.

So, too, in some cases of cancerous glands, associated with epithelioma—*e.g.*, of the tongue—the surgeon may justifiably perform an extensive operation, in the hope of removing both the primary and secondary epithelioma, or after a successful removal of the tongue operate on the infected glands widely and deeply to give the patient another prolongation of life. In such cases it should be the patient who urges the operation after all the risks have been placed before him.

Main Points in the Operation itself.

i. **Free Exposure of the Growth.**—The incisions should be sufficient, the flaps turned back, V, Γ, or X in shape. Thus, if the growth be in the anterior triangle, not encroaching on the posterior, a V-shaped flap with the base upwards, one limb

along the sterno-mastoid and the apex above the sternum, may be employed; or one Γ in shape, the long limb inside the above-mentioned muscle, and one at right angles to it under the jaw. If the growth invade both triangles, and if it will be necessary to divide the sterno-mastoid, an incision obliquely across both triangles, and over the muscle, from mastoid process to sternum, and then a second to make it conical, will be the best. It is always to be remembered that inadequate exposure of the tumour will lead to groping in the dark, bruising of the soft parts, and injury to important structures.

ii. **Deeper Dissection.**—In this attention must be paid to—

(a) Working as much as possible with a blunt dissector, a steel director, or the finger, or using blunt-pointed scissors, partly to act with and partly closed, as a blunt dissector and keeping the instrument used close to the growth. The dissection should be begun, as a rule, where the growth is most free, and where its relations are not important.

(β) Clamping or tying with reliable sulphuro-chromic gut every vessel before it is divided, not only to minimise the loss of blood, but also to avoid the risk of air entering the veins, especially low down in the neck.

(γ) Structures, hitherto thought too important, may be divided, if really needful. Thus, not only the sterno-hyoid and omo-hyoid should be divided, but the sterno-mastoid also. Of the structures in the carotid sheath, the internal jugular is, as pointed out by Mr. Holmes, the most likely to be implicated. It may be divided without hesitation after it is secured with two catgut ligatures.*

In the autumn of 1887, while operating for Mr. Cooper Forster, I tore through the internal jugular vein in removing some epitheliomatous glands: the hæmorrhage was for a moment very profuse, but yielded to sponge-pressure. Catgut ligatures were applied to the two halves of the vein, and the patient recovered. In a similar operation the lingual vein was separated so close to the internal jugular as to leave little more than a rounded opening. In preference to tying the vein above and below I left a pair of Spencer Wells' forceps on for three days. Recovery took place. The common carotid and even the vagus have been divided, and without a fatal result.

On two occasions in 1894, during the removal of epitheliomatous glands in the neck, I tied all three carotids and removed part of the vagus, and in one case the sympathetic (superior ganglion). In both the disease was secondary to cancer of the tongue, and in each case the mouth was sound. In the first, in which, in addition to ligature of the carotids, a portion of the vagus and the superior cervical ganglion were taken away, I had removed, four months before, the tongue, floor of the mouth and symphysis. The patient again recovered, and was alive and well three months later, though local recurrence behind the jaw is certain. In the second case two-thirds of the tongue had been removed three years before, and the patient had been able to keep his place as gamekeeper. He was fifty-seven, and the ligature of the three carotids proved rapidly fatal. When the insensibility of the anæsthesia should have passed away, the patient could

* Mr. Barker (*Lancet*, 1886, vol. i. p. 194) records a case, probably a cystic sarcoma, in which $1\frac{1}{2}$ inch of this vein and part of the scalenus anticus were involved in the growth and removed. The case did well.

not be roused; he gradually sank into coma, and died within forty-eight hours. Acute cerebral softening was found in the course of the middle cerebral artery.

In a deep dissection the presence of some other structures must be remembered.*

Mr. Godlee (*Clin. Soc. Trans.*, vol. xix. p. 321) showed a child in whom, during the removal of a deep-seated growth, the nature of which was doubtful and which was pressing upon the pharynx, the cervical sympathetic had been wounded. The only results were, that the pupil on that side was smaller but not stationary, and that the ocular slit was also smaller.

In 1870 I saw the thoracic duct opened in an operation for the removal of enlarged glands on the left side. Chyle escaped deep down in the wound, and the case soon ended fatally.

Prof. Keen has published four cases of injury to the thoracic duct during operations. Three of these recovered. One of these was a case of his own, in which the injury took place during a difficult dissection for the removal of matted tubercular glands lying above the left clavicle.

(δ) If possible, the growth-capsule, which is often soft and delicate, must not be ruptured. On examining the growth after removal, the capsule should not only be entire, but any process should be blunt and rounded, not soft and ragged, as if torn away from parts left behind.

If the surgeon feel doubtful as to any portion being left, as in the fossæ about the base of the skull, he should use a sharp spoon and Paquelin's cautery, or pack in lint with a paste of equal parts of zine chloride and flour (p. 274).

(ε) Throughout these operations, which may necessarily be prolonged and attended with loss of blood, and in which important parts may be disturbed and pulled upon, the surgeon should keep himself informed as to the effects of the anæsthetic.

iii. Closure of the Wound and Application of Dressings.—After completely removing the growth and any outlying glands, drainage is provided from the extremities of the resulting cavities, and in accordance with the position which the patient will occupy. Tubes of sufficient size being in position, the wound is brought together with wire or carbolised silk, or salmon-gut and horsehair sutures; dressings of sal alembroth or iodoform gauze are then adjusted, pressure being applied, wherever discharge might collect, with aseptic pads or sponges. Firm, even bandaging is then made use of to distribute the discharge equally throughout the dressings, and to keep the parts at rest. Owing to the mobility of the neck, and the impossibility of applying firm pressure over the trachea, it is always well to carry the bandages, below, across the axillæ, and, above, on to the face and forehead, and to have

* In the posterior triangle growths springing from the lower vertebræ or the first rib may involve the cords of the brachial plexus, causing much pain and requiring very tedious dissection for their removal. Such a case was brought before the Medico-Chirurgical Society, January 12, 1886, by Dr. Bruce and Mr. Bellamy.

them stitched together in several places. Unless it is absolutely indicated, the wounds should not be looked at for five or six days.

Operative Treatment of Scrofulous Glands.—This may be given here owing to the greater frequency of this disease in the neck. *Question of Operative Interference.*—The following abundantly justify something more vigorous than mere local treatment, when this has failed: (1) The fact that one gland has power to infect others, even when the local starting-point has been cured. (2) The disease, if merely palliated, is often extremely tedious, keeping the patient from the enjoyment and activity of some of the best years of life. (3) The scars which follow on a natural cure are far more disfiguring and extensive than those after a well-planned operation. (4) The long years a natural cure requires the repeated suppurations and the blighted days cause grave deterioration of the general health, which may persist for life, long after local cure has taken place. (5) The poor vitality thus induced, and in a large number of cases the actual presence of the tubercle bacillus, render the patient very liable to such diseases as phthisis.

The most useful methods are three—(A) Scraping or scooping out; (B) Excision; (C) Caustery-puncture, as practised by Mr. Treves (*Syst. of Surg.*, vol. i. p. 233).

(A) *Scraping or Scooping Out.*—I have put this first, as it is the method most often called for, owing to the frequency with which patients present themselves for treatment with one or more glands already caseating. It is applicable both in cases of glands caseating or suppurating, with the skin unbroken, and in those where a sinus already exists. Its value has been most clearly proved in the instructive papers on Scrofulous Neck and the Surgery of Scrofulous Glands put forth by Dr. Allbutt and Mr. Teale as clinical lectures at the Leeds School, from which so much good surgery has already come. The following are Mr. Teale's conclusions as to the surgical treatment of these cases; a wide experience has long ago convinced me of their absolute truth: (1) That surgery can secure the healing in a very few weeks* of gland cavities and sinuses, even though they have existed for years. (2) That, in dealing with sinuses, gland abscesses, and decayed or semi-decayed lymphatic glands, the action of the surgeon must be vigorous and thorough. (3) That the visible abscess, which would often be called, and treated as, a purulent suppurating gland, is, as a rule, merely a subcutaneous reservoir of pus, its source, a degenerate gland, being *not subcutaneous*, but *sub-fascial*, i.e., under the deep cervical fascia, and sometimes even sub-muscular, the communication between the two being a small opening just large enough to admit a probe or director. (4) That it is utterly futile merely to incise or puncture such a subcutaneous abscess dependent upon a degenerate gland which lies

* In severe cases several operations, three or more, will be needed. After the first one or two the general condition rapidly improves.

beneath the deep fascia. (5) That when a damaged or suppurating gland has been got rid of before the overlying skin is thinned by advancing suppuration, the resulting scar is insignificant and not an eyesore. (6) That, in dealing with a sinus, the channel should be enlarged by the knife or a "Bigelow's dilator," and the whole of its granulating surface scraped out. Where the skin is thin and blue, this should be scraped away, and any cutaneous overhanging edges trimmed off with scissors. (7) That, in dealing with a sinus or an abscess, the surgeon should not rest content until he has discovered and eradicated the gland, always remembering that, if it be not obvious, there is sure to be a small track leading to it through the deep fascia. This should be enlarged so as to admit a sharp spoon. (8) That, when a gland has suppurated or become caseous, the capsule should be freely opened and the contents scraped out. This is sometimes easy, the enucleation leaving the stiff capsular case virtually cleaned out. Sometimes it is very difficult to get rid, even by the most vigorous scraping, of a tough living stump of gland firmly adherent to the capsule. It is well to dissect this remnant away with a scalpel, if the risk of injuring important structures be not too great. (9) That sometimes, when such an empty capsule is left, the finger detects in its wall a bulging contiguous gland. This should be punctured through the wall of the cavity, and so reached and enucleated. In this way, in more than one instance, Mr. Teale has emptied from one external opening a group of three or four glands, suppurating or broken down.

I prefer to dress these cases, after scraping, with iodoform and hot boracic acid for a few days, as this best prevents cellulitis, while the moist warmth promotes the absorption of surrounding thickening and infiltration. A fine drainage-tube should also be inserted into the deepest recess. After a few days the above may be removed, and a small sealed dressing of dry gauze (see chapter on "Antiseptic Treatment") applied. Mr. Hilton long ago drew attention to the influence of rest in making otherwise intractable sinuses, &c., heal in a part so readily disturbed as the neck. Mr. Treves has, more recently, insisted on this point in the after-treatment of these cases. It is one of very great importance. Any of the leather collars which have been devised for cervical caries, and which, after careful moulding, take a fixed point on the shoulders below, and bear up efficiently the jaw and occiput above, will suffice. If, in very restless mortals, it is impossible to get a fixed point from the shoulders and root of the neck, the collar must have its base moulded round the thorax. When the parts are thus kept at rest, the child must spend its time out of doors in the best air available.

(B) *Excision*.—The cases to which this is best suited are those where there are two or three conspicuous glands—*e.g.*, in the sub-maxillary region—which have resisted treatment, and which, being movable and not yet softened, will shell out readily. And where, in scraping, glands are met with which have not suppurated, and

which are fairly movable, they should be enucleated. This can sometimes be done even when one gland has suppurated. By dilating freely the opening in the deep fascia one or more glands may be turned out entire without any fresh incision being made. With regard to a third class, where one or both triangles are full of glands, an operation, by competent hands, on the lines already laid down in this chapter, may be very beneficial. But with regard to these extensive cases, Sir W. Savory's warning, quoted by Mr. Treves (*loc. supra cit.*), must always be remembered: these glandular swellings are often very deceptive; however well defined, superficial, and movable they appear through the skin, they will often be found, in an operation, to creep into parts very difficult of access, and to lead on to other and other glands, till perhaps the operation closes with as many left behind as have been removed.

(C) *Treatment by the Caustery*.—This has been recommended by Mr. Treves (*loc. supra cit.*). He uses a fine point of a thermocautery, heated to a bright red, thrust into the substance of the gland, and passed through it in several directions before it is withdrawn. Broken-down tissue is discharged, and the gland soon shrinks. I much prefer the sharp spoon to this method, not only because I think the operation more thorough, less in the dark, and an aseptic one, but also because gland-tissue blended with a thick capsule, adherent to, and receiving its blood-supply from, the adjacent parts, will persist almost for a lifetime, unless completely eradicated. This, failing excision, can, I think, be only efficiently done by scraping.

It is the persistence of this poorly but sufficiently vitalised gland-tissue which renders merely opening an abscess, the floor of which is formed by an imperfectly broken-down gland, so often futile unless the sharp spoon is used.

CHAPTER XV.

OPERATIONS ON THE ŒSOPHAGUS.

ŒSOPHAGOTOMY, ŒSOPHAGOSTOMY, ŒSOPHAGECTOMY.

ŒSOPHAGOTOMY.

Indications.—This is required for such foreign bodies—*e.g.*, tooth-plates, bones, coins—as have resisted careful, justifiable attempts at extraction, bodies which are certain, if left, to lead to grave results—*e.g.*, hæmorrhage, sloughing, deep cervical suppuration, &c.

It will be wise to proceed to an early operation, and thus avoid the risks of a fatal result from those conditions given at p. 460. In making up his mind to submit his patient to an operation, the surgeon must weigh the size and character of the body, the time it has been swallowed, the urgency of the symptoms—*e.g.*, dysphagia, dyspnœa from pressure on the larynx, emphysema,* œdema, &c., and whether the attempts already made at extraction are all that are justifiable, and whether the instruments at hand have been appropriate.

Operation.—The head being somewhat extended and turned to the right† side, the neck shaved (if needful), the surgeon makes an incision 3 inches long from just above the thyroid cartilage to within $\frac{1}{2}$ inch of the sterno-clavicular joint,‡ a little in front of

* In a case where emphysema already exists with an impacted foreign body it will be wiser to open the œsophagus at once, and not make attempts at extraction. Dr. Church (*St. Barthol. Hosp. Reports*, vol. xix. p. 55) gives a case in which swelling of the neck began three hours after the tooth-plate had been swallowed. The next day, after several attempts with a horsehair probang, the plate, which lay midway between the larynx and the sternum, was brought up into the reach of forceps and extracted by Sir W. Savory. Death took place two days later, there being perforation of the end of the pharynx, with suppuration in the neck, mediastina, and left pleura.

† The left side is preferable, as the œsophagus lies more to this side, and as operating on the left side allows of freer movement of the right hand, while the left is at liberty to move the larynx, &c.

‡ If the neck is very stout, or if the parts are swollen, &c., the incision may be from just below the angle of the jaw to close to the sternum.

the anterior border of the sterno-mastoid. Skin and fasciæ being divided,* the cellular tissue in front of the above-mentioned muscle is opened up with a director, and the pulsation of the artery and the bodies of the cervical vertebræ, fifth and sixth, felt for. The omo-hyoid may be drawn down, but it is best to divide this muscle between chromic-gut ligatures, and, if it be needful to seek for the body low down in the neck, the sterno-hyoids and sterno-thyroids also. The sterno-mastoid and large vessels are now drawn outwards, and the trachea † inwards, with retractors, the thyroid gland probably showing plainly on the inner side, and the internal jugular, if dilated, on the outer. The presence of the inferior thyroid behind the carotid sheath, and that of the recurrent laryngeal running up in the groove between the trachea and œsophagus, must be remembered. Throughout these steps of the operation the bleeding must be most carefully arrested, and the deeper part of the wound, with the important structures around it, kept quite dry.

If the foreign body cannot be felt ‡ projecting in the œsophagus—*e.g.*, behind the cricoid—the mouth should be opened with a gag, and a bougie or probang passed, as the flaccid tube-walls are naturally in contact. When the œsophagus lies unusually deep, following round the thyroid or cricoid cartilage with the finger will find it.

When the site of the foreign body has been made out, or when, failing this, it is decided to open the œsophagus low down and to pass probes, &c., a clean incision must be made as far back as possible, so as to avoid the recurrent laryngeal filaments.§

When the tube has been opened, and any bleeding from its walls arrested, the opening is dilated by dressing-forceps, by a probe-pointed bistoury, or by curved forceps passed from the mouth and expanded in the wound. Even after a free opening has been made it may be impossible to dislodge the body, if this, a tooth-plate, has projecting clips, or if it is tightly embraced by the contraction of the œsophageal fibres. In such a case the body should be (if a tooth-plate) divided with bone-forceps and removed in two portions, care being taken to keep hold of each portion with forceps (Lawson, *Clin. Soc. Trans.*, vol. xviii. 292).

* The anterior jugular vein may give trouble, and should be drawn aside, or divided between two catgut ligatures.

† The larynx should not only be drawn to the right, but tilted over to this side also, as this brings up the œsophagus.

‡ It must always be remembered that the precise site of the foreign body is not always marked by any external swelling or resistance, nor by accurately referred pain; furthermore, bougies occasionally give very slight indications of the presence of bodies (even rough ones) in the œsophagus or pharynx.

§ Mr. Cock (*Guy's Hosp. Reports*, 1868, p. 3) draws attention to this point. Both his patients were in the habit of singing; in the first case (*ibid.*, 1858, p. 229) a fine tenor voice was replaced by a bass; in the second, in which the œsophagus was opened farther back, the voice did not suffer.

If, after exposing the œsophagus, the body cannot be felt, which will rarely happen, metallic probes or soft bougies should be passed through the wound in the œsophagus, and the lower cervical, and the upper thoracic, portions of this tube carefully explored. The question may now be considered: How far down from the œsophagus can a body be extracted? The most accessible part is no doubt its junction with the pharynx, opposite to the cricoid cartilage, and the first two inches below this point. Mr. Cock (*loc. supra cit.*) writes: "It might even be possible to extract a foreign body from the early thoracic portion, provided it could be reached with the finger, and thus brought under the influence of a pair of curved forceps."*

As far as my knowledge goes, the lowest point from which a foreign body has been removed occurred in the practice of Mr. Bennet May.

Here a child, aged seven, had swallowed a halfpenny three and a half years before. The coin had ulcerated through the œsophagus and opened the right bronchus, lying partly in this and partly in the œsophagus. It was removed successfully by œsophagotomy.

When the foreign body has been removed, the question of introducing sutures into the œsophagus will arise. These should only be used when the wound in the gullet is clean cut, not bruised, and when the body has been quickly removed; the sutures should be of fine chromic gut and only the upper part of the wound in the œsophagus should be closed, the rest being left open to the bottom to allow of free drainage, owing to the danger of sloughing, pent-up foul secretions, and blood-poisoning (p. 460).† A drainage-tube should be inserted to the bottom of the wound, iodoform dusted in,

* The proximity of important parts to the thoracic portion of the œsophagus is well known. Thus, in *Path. Soc. Trans.*, vol. xix. p. 219, is recorded the case of a man who swallowed a bone which lodged in the œsophagus opposite to the arch of the aorta. Death took place suddenly on the fifth day from perforation of the aorta and hæmorrhage, after a slight exertion. Mr. Eve (*Clin. Soc. Trans.*, vol. xiii. p. 174) gives a case in which a fish-bone, impacted in the œsophagus, wounded the heart fatally. It was thought that the position of the fish-bone was perhaps due to previous use of the probang.

† If there is any doubt, sutures had far better be dispensed with. Dr. Barton (*Ann. of Surg.*, July 1887) has recorded a case of successful œsophagotomy in a little child—the age does not appear to be given. The foreign body, a small steel roller of a sewing-machine, had been swallowed three months before. This was extracted through a very small opening in the œsophagus "after the manner of working a stud through a button-hole which is too small for it," from the fear of causing a fistula if the opening was enlarged. The wounds in the œsophagus and superjacent parts were separately sutured. Epileptic fits soon followed, and frequent vomiting tore open the wound. The fits having ceased with the administration of potassium bromide, the wound in the œsophagus was pared and sutures re-applied as before. This limited much the escape of fluids through the wound, but did not entirely stop it. The passage of a tube through the mouth twice a day caused so much irritation that it was abandoned, and the tube passed through the wound. The wound healed slowly though surely. Dr. Barton is inclined to recommend this way of feeding when primary union is not secured.

a few sutures placed in the edges of the wound, dry dressings applied—viz., iodoform gauze, salicylic wool, &c., if the wound has not been much probed about, and there is thus good reason to expect early union. But if ulceration of the soft parts has been found, if they are inflamed, emphysematous, &c., the wound should be left open, drained to the very bottom, and lint soaked in hot, saturated, boracic-acid solution applied and frequently wetted.

After-treatment.—If the patient is in good condition, if the foreign body has been removed early, or if the patient has been able to swallow liquids in the interval between the accident and the operation, he may be fed for the first few days by nutrient enemata and nutrient suppositories,* and only a little ice given occasionally by the mouth. But if the strength is not satisfactory at the time of the operation, or if the enemata are not retained, a soft feeding-tube must be made use of. This should be passed by the mouth and retained, if not very uncomfortable to the patient, or passed at intervals.† Towards the end of the first week, perhaps earlier, if the wound is healing well, the patient may be allowed to swallow a little diluted wine or milk.

Chief Difficulties.

- | | |
|-----------------------------------|--|
| 1. A fat, short neck | 6. Detecting the site of the foreign body. |
| 2. Enlarged veins. | |
| 3. Wide depressors of hyoid bone. | 7. Firm gripping of the body by the œsophagus. |
| 4. Enlarged thyroid gland. | 8. The foreign body may be dis- |
| 5. Unusual depth of œsophagus. | lodged during the operation. |

Dr. Lediard (*Clin. Soc. Trans.*, vol. xviii. p. 297) records the case of a man in whom emetics and several attempts at removal had failed to dislodge a tooth-plate; emphysema of the neck was present, and some blood on the forceps used. Just before œsophagotomy, a bougie was thought to "scrape" as it was withdrawn. Nothing being felt when the œsophagus was exposed, a bougie was passed, and the œsophagus incised behind the cricoid cartilage; the finger now

* Of these, the zymised meat suppositories of Burroughs & Wellcome are amongst the best.

† Dr. Markoe (*Ann. of Surg.*, September 1886), in the case of a man, aged twenty-four, from whom he removed, by œsophagotomy, half a tooth-plate, which had been broken in eating, passed a soft india-rubber tube into the stomach through the wound, replacing this by one passed through the nose on the tenth day, and allowing the patient to swallow on the seventeenth day after the operation. The following are the reasons given for passing the tube through the wound:—(1) It ensures good drainage from the bottom of the wound; (2) anything regurgitated from the stomach passes through the tube, not up into the wound; (3) it is less unpleasant. The above reasons do not seem to me to outweigh the great risks and disadvantages of irritating and keeping open the wound, which it is desirable to have closed as soon as possible. As a rule, the tube should certainly be passed from the mouth or nose. It is noteworthy that in the above case the prolonged lodgment of the foreign body—six to seven weeks elapsing between the accident and the operation—had not caused any serious abrasion, &c.

could feel nothing, and a bougie passed on seemed to feel the plate near the stomach. The plate was passed nineteen days after its impaction; it measured $1\frac{1}{2}$ inch by $\frac{3}{4}$ inch, carried one incisor, and had "numerous sharp points, and a formidable-looking hook at one end." Though there were no laryngeal symptoms, the plate must have been lying behind the lower end of the larynx, as the mucous membrane of the gullet showed here several ecchymoses. The dislodgment of the plate took place either during the passage of the bougie, or in the administration of the anæsthetic. The patient made a good recovery.

Causes of Death.—These are chiefly:

1. Septicæmia.* The wound having become emphysematous, sloughy, and the discharge most foul.

2. Exhaustion. When the body has been long impacted, and the patient's health has run down before the operation.

ŒSOPHAGOSTOMY.

This has been proposed as a substitute for gastrostomy. Mr. Reeves, who brought this subject before the Clinical Society,† recommended this operation as less dangerous than gastrostomy, and in the belief also that cancer of the œsophagus is most frequently met with in the upper part of the tube.‡ The objections, however, are so great as to have prevented any adoption of this operation. They are—(1) the risk of coming close to a mass of cancer, which will not only not admit of dilatation, but which will be rendered more active, sloughy, &c., by the necessary irritation. (2) The fact that important parts are close by, and that the relations of these may very likely be much altered. (3) The probability of finding the œsophagus altered near the disease, and thus, perhaps, readily perforated, admitting fluids into the pleura, &c.

ŒSOPHAGECTOMY.

This is another operation which has been introduced only to be abandoned. Prof. Czerny's case, it is true, was temporarily successful, the patient living rather more than a year after the

* Mr. Butlin (*Clin. Soc. Trans.*, vol. xvii. p. 129) relates a case in which a tooth-plate was removed within twenty-four hours of its being swallowed, previous attempts at removal, lasting thirty or forty-five minutes, having failed. No difficulty was experienced during the operation, but the patient sank from septicæmia four days after the operation. He was allowed to swallow on the second day, about a third of what was taken coming through the wound. Mr. Butlin considered this beneficial, as conducing to drainage. The wound was thoroughly washed with carbolic lotion and covered with carbolic oil. Two days after, the wound being very offensive, the dressing was altered to sanitas, changed every four hours.

† *Trans.*, vol. xv. p. 26.

‡ Most surgeons who have been called upon to pass bougies in these cases will agree with Dr. Goodhart, who, in the discussion on the above paper, said the disease usually extended from the cricoid cartilage nearly to the pylorus.

operation. But cases equally suitable from the site of the disease—only just out of reach of the finger introduced from the mouth—with no glands involved, and no adhesions to adjacent parts, though symptoms had lasted five months, must be quite exceptional. Several of the risks given above would be intensified here, and there would be present as well the need of keeping the fistula patent.*

* Mr. Butlin (*Oper. Surg. Malig. Dis.*), to whom I am indebted for Prof. Czerny's case, gives one of Prof. Billroth's, where death was caused by the passage of the bougie into the tissues round the œsophagus, the opening where the lower end of the œsophagus had been stitched to the skin having contracted.

CHAPTER XVI.

OPERATIONS ON THE SPINAL ACCESSORY NERVE.

PARTIAL NEURECTOMY, OR NERVE-STRETCHING.

Indications.—In cases of spasmodic torticollis in which 1. All previous palliative treatment has failed—*e.g.*, large doses of conium, massage, galvanism of the affected side, and faradisation of the opposite muscles. 2. The spasms are so severe and constant as to interfere with the patients taking food or enjoying sleep, and to cause sad weariness and real suffering. 3. The only muscles affected are the sterno-mastoid, or the sterno-mastoid and trapezius.

Anatomy of Spinal Accessory Nerve.—The spinal or external part of this nerve, having left the skull by the jugular foramen, is directed backwards in front of, or behind, the internal jugular vein, and appears below the digastric and the occipital artery. It then descends obliquely outwards to the sterno-mastoid muscle, and disappears under this at a distance of 2 inches from the apex of the mastoid process. Having usually perforated the muscle, the nerve passes across the posterior triangle to end in the deep surface of the trapezius. While passing through or under the sterno-mastoid the nerve joins with branches from the second cervical. Having emerged from the muscle, it joins with the second and third nerve, and is often in intimate connection with the great auricular and small occipital. When under the trapezius it is joined by branches of the third and fourth cervical.

Operations for Partial Neurectomy, or Stretching of the Nerve.—These may be considered together, but it may be said, once for all, that, as stretching will be followed by but temporary benefit, resection of the nerve will be the better operation.

The nerve may be found by two different incisions.

A. Along the anterior border of the sterno-mastoid so as to come upon this nerve before it perforates this muscle.

B. Along the posterior border of the muscle, the surgeon finding the nerve as it emerges here to cross the posterior triangle to gain the trapezius, and following it up above its branches to the sterno-mastoid, so as to paralyse this muscle also.

The first of these operations is in my opinion much preferable, and for these reasons :

1. Though the nerve lies more deeply at the anterior than at the posterior border of the muscle, it is here a single nerve, and not likely to be confounded with other nerves—*e.g.*, branches of the second and third cervical, which also emerge at the posterior border to supply the skin. Furthermore, in this latter position, the spinal accessory is often found in close connection with the small occipital and great auricular, as these two nerves appear at the posterior border and curve upwards.

2. By finding the nerve at the anterior border of the muscle paralysis of the sterno-mastoid is better ensured. When the nerve is found at the posterior border and followed up into the muscle before division, there is always an uncertainty as to whether some branch to the muscle may not have come off above the point at which the surgeon has divided the nerve. And though the nerve is more superficial in the posterior triangle, it is difficult to make certain whether it is the spinal accessory or one of the superficial cervical nerves which emerge close to it, from behind the muscle (p. 462).

A. Operation above Sterno-mastoid.—The parts being shaved and cleansed, and the head suitably raised and turned to the opposite side, the surgeon makes a free incision along the anterior border of the sterno-mastoid for 3 inches, commencing at the apex of the mastoid process and ending about 2 inches below the angle of the jaw. Skin, fasciæ, and platysma being divided, the anterior border of the sterno-mastoid is clearly defined and drawn strongly backwards so as to put the nerve on the stretch. In doing this the posterior and lower part of the parotid may have to be drawn forward if this gland overlap the muscle. The wound being then thoroughly dried, the operator searches for the nerve with a steel director in the fatty connective tissue which lies between the muscle and the carotid sheath. If, in doing this, he keeps for his landmark the angle of the jaw, he is almost certain to be on a level with the point where the nerve enters the muscle. If this landmark fail him, he should define the lower border of the digastric, and tracing upwards the posterior belly of this muscle, feels for the transverse process of the atlas, between the front of which process and the posterior belly of the digastric the nerve emerges to pass backwards to the sterno-mastoid. The small branch from the occipital artery which accompanies the nerve will give no trouble; and if in the deeper parts of the wound only a steel director or a blunt dissector is used, neither the occipital artery nor the internal jugular vein will be injured.

B. Operation Below or at Posterior Border of Sterno-mastoid.—Mr. Campbell de Morgan, who introduced this operation into British surgery with a very successful case,* made an incision,

* *Brit. and For. Med.-Chir. Rev.*, July 1866. I performed the same operation on a middle-aged woman about seventeen years ago at Guy's Hospital in a very severe case of spasmodic torticollis. The right sterno-mastoid and trapezius were

2 inches long, along the posterior border of the sterno-mastoid the centre of the incision corresponding to about the centre of this border of the muscle. The fascia being slit up to the same extent, the trapezial branch of the nerve was sought for as it emerges from the sterno-mastoid to cross the posterior triangle. I was found a little above the centre of the wound, and traced through the muscle till the common trunk was discovered above its division into branches for the trapezius and sterno-mastoid. Half an inch of the nerve was then cut out.

I have twice performed the operation of resection of part of the spinal accessory, employing each of the two methods given above.

Thus, in 1878, I found the nerve in the posterior triangle, and tracing it upwards removed a portion of the common trunk in the substance of the sterno-mastoid. In 1894 I found the nerve at the anterior border of the muscle, taking as my guide the angle of the jaw. Both patients were middle-aged women, the subjects of severe spasmodic torticollis. In each case some of the deep cervical muscles supplied by the upper cervical nerves were affected, and in neither was the result as satisfactory as I wished. In the first no permanent benefit can be said to have resulted. In the second the relief was considerable, and the patient has, hitherto, declined further operation, in the form of division of the posterior branches of the cervical nerves. Atrophy of the muscles followed in each case.

There is no comparison between the two methods, that in which the nerve is found at the anterior border of the muscle being infinitely easier and more satisfactory.

A very interesting contribution to the literature on this subject is a paper by Mr. Ballance.*

His patient, a woman of forty-eight, was a good instance of the distress and misery due to spasmodic torticollis. Division of the right spinal accessory in the anterior triangle gave most decided relief. At the end of four months, when the history ceases, the patient is reported to have been "much better and stouter. The face is happy and tranquil. There is neither headache nor pain, and sleep and appetite are good. The control of the movements of the head is perfect as long as she is not excited, and so long as the head is not raised so that the eyes are directed much above the horizontal plane in which they lie. . . . The right sterno-mastoid and trapezius are atrophied."

Division of the spinal accessory deserves a further trial, even if the relief given is not permanent.

The chief fear is that other muscles will become involved, as in my cases. Thus, Mr. Ballance writes of his patient: "Since the operation, it has been certain that some of the muscles supplied by the upper spinal nerves are liable to spasm. It would be strange if it were not so, considering the intimate connections between the second, third, and fourth spinal nerves and the spinal

paralysed and rendered quiescent, but some of the deeper muscles on the opposite side—viz., the splenii—became affected, and no permanent benefit resulted.

* *St. Thomas's Hosp. Reports*, vol. xiv. p. 95. Other successful cases will be found recorded by Prof. Annandale (*Lancet*, 1879, vol. i. p. 555) and by Mr. Southam (*Ibid.*, 1881, vol. ii. p. 369); Mr. Rivington also operated (*ibid.*, 1879, vol. i. p. 213), but phlegmonous erysipelas carried off the patient before the wound was quite healed.

accessory in the sterno-mastoid, trapezius, and posterior triangle, together with the fact that some of the fibres of the spinal accessory are connected with the same cells, or with cells in the immediate neighbourhood of those from which arise the motor rootlets of the cervical spinal nerves."

Resection of some of the Branches of the Upper Cervical Nerves.—In those cases of spasmodic torticollis where, after resection of part of one spinal accessory, mischief still persists in muscles of the opposite side, this step has been practised by Mr. Noble Smith in this country, and by Prof. Keen of Philadelphia. The following is the account of the steps taken by Mr. Noble Smith (*Brit. Med. Journ.*, vol. i. 1891, p. 753):

The patient was a lady, aged forty-one, in whom the above surgeon had first stretched and then resected part of the left spinal accessory. Though the result of the latter operation was "complete paralysis of the sterno-mastoid and trapezius, the spasms on the right side continued, the splenius capitis being the greatest offender. On May 28, 1890, I made an incision from the occiput downwards for about 3 inches, parallel to and about an inch to the right of the spinous processes, through the trapezius down to the edge of the splenius, some of the fibres of which muscle I had subsequently to divide to enlarge the wound, then through the complexus and eventually exposed the posterior branches of the cervical nerves. The great occipital then came into view, and this I had to draw aside. I excised a piece of the external division of this nerve, also of the third and fourth posterior branches. Considering the extensive connection of nerves in this part I thought it well to separate the splenius from the parts beneath it, and search for and divide any filaments of nerve passing into that muscle. I also acted in the same manner towards the complexus. I had intended to try and excise a piece of the sub-occipital nerve, but having already made a rather deep dissection, and found that some veins interfered with such further operation, I desisted from doing any more. . . . The first night of the operation, the patient, for the first time for sixteen years, was able to rest her head on her pillow without spasmodic action. This good result has continued. . . . The loss of power proved to be very slight indeed."

Prof. Keen's method is different (*Journal of Nervous and Mental Diseases*, Dec. 1889):

The parts being shaved and disinfected, a tranverse incision, 3 inches long, is made about half an inch below the lobule of the ear, from the middle line of the neck posteriorly. The trapezius is then divided transversely, dissected up, and the great occipital found as it emerges from the complexus, usually about half an inch below the incision, to enter the trapezius. The complexus is next divided at the level of the nerve, care being taken not to cut the nerve, which is then traced down to its origin from the posterior division of the second cervical. A portion of this division is resected. The inferior oblique being recognised, the sub-occipital is traced into its triangle and a portion resected. An inch below the great occipital, and under the complexus, is the outer branch of the posterior division of the third cervical to the splenius. This should be resected close to the bifurcation of the main trunk. The wound is very deep, and an electric light will be found a great help. Drainage must be provided, and the divided muscles may be united by buried sutures.

CHAPTER XVII.

LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.*

LIGATURE OF THE TEMPORAL ARTERY.

Indications.—These are very few, viz. :

1. Wounds—*e.g.*, stabs and gunshot injuries.
2. Aneurism, usually traumatic.

Mr. Skey (*Oper. Surg.*, p. 289) met with a case of aneurism of doubtful origin in this artery in a young lady. Ligature of the vessel below having failed, he cured his patient by means of a fine spring compress with a ball-and-socket joint which, passing over the head, entirely concealed by the hair, made pressure on the tumour.

Aneurisms have been known to occur here after the operation of arteriotomy.

GUIDE.—A line drawn upwards over the root of the zygoma, midway between the condyle of the jaw and the tragus.

RELATIONS.—Given off behind the jaw, this vessel passes up midway between the above two points over the zygoma, and at a point $1\frac{1}{2}$ or 2 inches higher up it divides into its anterior and posterior branches. Lying at first in the parotid gland, it is covered a little higher up by a dense fascia passing from the parotid to the ear, by the *attrahens aurem*, often a lymphatic gland, and one or two veins which lie superficial but close to it. Some branches of the facial nerve cross it, while the auriculo-temporal nerve accompanies it closely. Higher up, the artery and its branches are particularly subcutaneous.

Operation.—The parts being shaved and cleansed, the head fitly supported and turned to the opposite side, an incision about 1 inch long is made in the line of the artery so as to tie it just above the zygoma. The dense subcutaneous tissue and the strong parotid fascia being cleanly divided, the artery must be accurately defined, and the vein being drawn to one side, usually backwards, the ligature should be passed from behind forwards, care being taken to include only the artery.

Arteriotomy.—A few words may be said here about this seldom-used operation. The surgeon, having defined the anterior division

* Ligature of the thyroid arteries has already been considered, chap. xiii. p. 443.

of the temporal, steadies the vessel by placing his finger just beyond the point which he intends to open, and then with a small sharp scalpel lays open the vessel till it is about half cut through. The blood required having been removed, he divides the vessel completely, so as to allow the ends to retract, applies a pad of aseptic gauze or of lint and iodoform, and retains this in position with the twisted or knotted bandage for the head. The pad should not be removed for four or five days.

The reasons for preferring the anterior division to the trunk of the vessel are the following:

(1) The latter lies much more deeply, under fasciæ, and in the parotid below; thus so much pressure may be required to stop the bleeding as to cause sloughing, secondary hæmorrhage, and dangerous erysipelatous inflammation.

(2) Injury to one of the adjacent nerves may cause severe pain and tedious healing.

(3) From opening a vein at the same time an arterio-venous aneurism may result.

LIGATURE OF THE FACIAL ARTERY.

Indications.—These are much the same as, but still fewer than, those for ligature of the temporal artery.*

The vessel's course is divided into a cervical and a facial part.

Cervical Part.—Ligature here can be scarcely ever required. The vessel could be reached here by an incision similar to that for the external carotid (p. 497) or the lingual (p. 470). In either of these cases the vessel would be found just below the posterior belly of the digastric and the stylo-hyoid, these muscles being drawn upwards to enable the surgeon to tie the vessel just before it enters the sub-maxillary gland.

RELATIONS IN THE NECK.—The facial artery is given off just above or in connection with the lingual, about an inch above the bifurcation of the common carotid. It ascends upwards and inwards to the lower jaw, being covered by skin, fasciæ, and platysma, the digastric and stylo-hyoid, and being embedded in the sub-maxillary gland, to which structure the vein lies superficial. The tortuous outline of the vessel is well known. The vein, running a straighter course, lies posterior to the artery.

Facial Part.—The artery is readily secured by a small horizontal incision just below the jaw in front of the masseter muscle, the anterior border of which should be first defined, this being easily done on the living subject by telling the patient to throw it into action. The incision should be made carefully, so as to avoid any branches of the facial nerve which may lie in the way. The artery

* The reader is advised to take every opportunity afforded upon the dead body to tie these and other arteries, though apparently so small and unimportant, as only by such practice can dexterity be really acquired.

will now be felt when rolled upon the bone by a finger; the ligature should be passed from behind forwards so as to avoid the adjacent vein.

LIGATURE OF OCCIPITAL ARTERY (Fig. 137).

Indications.

1. Stabs.
2. Gunshot wounds.

In the *Medical and Surgical History of the War of the Rebellion*, part i. p. 422 two cases are given of secondary hæmorrhage after wounds of the neck, in the one case from the occipital, in the other from a branch of it; in the former case 16 ounces of blood were lost. The vessel was tied in the wound in each case two ligatures being, of course, applied.

3. In the treatment of arterial varix, cirroid aneurism, or aneurism by anastomosis on the head (p. 492).

4. For hæmorrhage from an abscess in the neck. Mr. Banks has published a most instructive case.

A weakly man, aged thirty-two, had had a suppurating gland incised three weeks before admission. Poultices were applied, and, a week after, during violent attack of coughing, blood burst from the wound "like a tap being turned on." Three times afterwards hæmorrhage ensued, pressure being applied in vain. On admission he was in the last stage of exhaustion. The right side of the neck from ear to clavicle was occupied by a great fluctuating swelling. In front of the sterno-mastoid, about half-way down, was the original incision, from which a little sanious discharge was issuing. Behind the muscle a piece of skin about an inch square was actually sloughing from the subjacent pressure. Under ether, and in a good light, the original incision was enlarged upwards and downwards, and a quantity of putrid broken-down clot turned out. Then a similar incision was made behind the sterno-mastoid through the sloughing skin. Everything being mopped and cleaned up, blood was found to be trickling down from somewhere very high up. To get at it, the sterno-mastoid and skin over it were cut clean across, thus uniting the two vertical incisions by a transverse one. The muscle was dissected upwards, exposing the sheath of the carotid vessels, but still the blood always kept running from some deep-seated point high up. At last this was reached, just in front of the transverse process of the atlas. From it arterial blood issued, and an aneurism needle was thrust through the tissues on each side of it and ligatures applied, which at once checked all further bleeding. The vessel was the occipital artery not far from its origin. Into it the abscess had made its way. The great wound was rapidly swabbed out with turpentine and then stuffed with lint dipped in the same. The patient was very near to death's door, but ultimately recovered.†

* *Clinical Notes upon Two Years' Surgical Work at the Liverpool Royal Infirmary* p. 161.

† Such was the patient's condition that the surgeon was quite prepared for his dying under the operation. The following characteristically vigorous word concludes the account: "But I was determined as long as he had any blood to run out of him, the place whence it came should be found and tied." In connection with this case may be quoted, in his own words, some remarks of Mr. Banks on the value of turpentine as a cleansing styptic. This remedy has again lately been recommended, and it is only fair that Mr. Banks should have the credit of having recognised its value many years ago. "In former days it was the

RELATIONS.—A posterior branch of the external carotid, the occipital comes off opposite to or a little above the facial, just below the digastric. It at first ascends, having the ninth nerve hooking round it, under the digastric, stylo-hyoid, and parotid, and crossing the internal carotid, internal jugular, vagus, and spinal accessory. Having reached the interval between the transverse process of the atlas and the mastoid bone, it now, in the second part of its course, turns horizontally backwards, grooving the temporal bone, covered by the sterno-mastoid, splenius, digastric, and trachelo-mastoid, and lying on the complexus and superior oblique. In the third part of its course it runs vertically upwards, piercing the trapezius, and ascending tortuously in the scalp.

Operations.

1. If the artery require securing low down, this may be effected much as in tying the external carotid, an incision being made along the anterior border of the sterno-mastoid, the deep fascia opened, and the digastric and ninth nerve exposed. Care should, of course, be taken to avoid the latter.

2. To tie the artery behind the mastoid process (Fig. 137), *e.g.*, when it has been wounded by a stab in the neck, the following steps should be taken: The parts being shaved, and the head at first being placed in much the same position as for ligature of the carotids, an incision is made from the tip of the mastoid process rather obliquely upwards, so as to lie over a point midway between the mastoid and external occipital protuberance. The tough skin and fasciæ being incised, the posterior half of the

regular thing for oozing, until superseded by the introduction of perchloride of iron. This has always seemed to me most unfortunate, as iron is the very worst of all styptics. Owing to its great potency and the rapidity with which it acts, it soon became popular, and is at the present moment the favourite standby of the chemist, who diligently swabs with it every cut that is brought into his shop, preparatory to sending the patient off to a hospital. As a result, the wound is covered with a cake of coagulated blood, and its surfaces are sometimes positively killed by the strength of the application. Beneath this firmly adherent crust all sorts of purulent, filthy secretions accumulate, till at the end of forty-eight hours it stinks abominably, and requires to be well poulticed to get it clean. Should bleeding recur, the difficulty of finding the spot is enormously increased by the mass of pus and almost cineritious hard clots which cover it. I have seen so many cut hands almost ruined by it that I have totally abandoned it. On the other hand, turpentine is nearly as powerful a styptic, and is a most marvellous cleanser and sweetener. The plug soaked in turpentine comes out quite easily at the end of four-and-twenty hours, leaving a wholesome surface behind it. For all wounds about the perinæum, such as lithotomy wounds, fistula, cuts, or incisions for extravasation of urine, there is nothing like it, and I trust it will soon be reinstated in surgical favour. Our forefathers had some excellent remedies, and this is one of them." I have used sal alembroth gauze soaked in turpentine, with excellent results, after removal of a kidney the seat of a mostetid discharging pyonephrosis. Only the gauze, &c., in the wound must be thus soaked.

sterno-mastoid, with its strong aponeurosis, and next the splenius capitis, must be divided, together with any fibres of the trachelo-mastoid that are in the way. The wound being somewhat relaxed by turning the head over to this side, retractors deeply inserted and a laryngeal mirror used if needful, the artery will be found deep down between the mastoid bone and the transverse process of the atlas.

In separating it from its vein, one or more veins varying in size may be met with, forming communications between the occipital and mastoid veins, and thus with the lateral sinus. The wound should therefore be kept rigidly aseptic.

LIGATURE OF THE LINGUAL ARTERY (Fig. 132).

Indications.

1. Before removal of the tongue. This subject has been considered at p. 369. 2. After removal of the tongue, to arrest hæmorrhage. 3. In cases of tongue cancer not admitting of operation, in the hope of checking the rate of growth, diminishing the fœtor, profuse salivation, &c. This step is uncertain as to the amount of good which it effects, and any good that it may do will not be long-lived.* 4. In cases of macroglossia this operation may be tried before removing a wedge-shaped piece of the tongue; it would require to be performed on both sides, and would be attended with considerable difficulty in a child.

RELATIONS.—The lingual artery arises about $\frac{1}{4}$ inch above the superior thyroid, often in common with the facial, and at a point opposite to the great cornu of the hyoid bone. It first ascends to a point rather above the level of the hyoid bone, then descends somewhat and runs just above the great cornu, and finally, ascends

* Mr. Haward (*Clin. Soc. Trans.*, vol. x. p. 129) related a case in which he tied the left lingual artery for recurrent epithelioma. The recurrent growth was the size of half a walnut when the lingual artery was tied. It at once ceased to grow, became pale, and in a few days was sloughing. Gradually separation of the growth went on, until the affected side of the root of the tongue became even smaller than the sound side, and eventually the part healed. A fortnight after this took place, or three months after the ligature of the artery, the patient died of pyæmia, set up by erysipelas coming on after the operation. Mr. Haward pointed out that the greater part of the tongue had been removed before the ligature of the lingual, so that therefore the anastomoses between the arteries of the two sides would be greatly diminished. I think, also, that the fact that Mr. Haward was obliged to tie the artery close to the external carotid may have contributed to the sloughing, by cutting off the entire blood-supply, especially that through the dorsalis linguæ.

On the other hand, Billroth (*Clin. Surg.*, p. 113) states that, in one case of cancer of the tongue, "the lingual artery was ligatured on both sides, in the hope that the infiltration of the tongue in the cavity of the mouth might diminish. However, the ligature led to no good results, nor did any rapid breaking-down of the already ulcerated new formation occur."

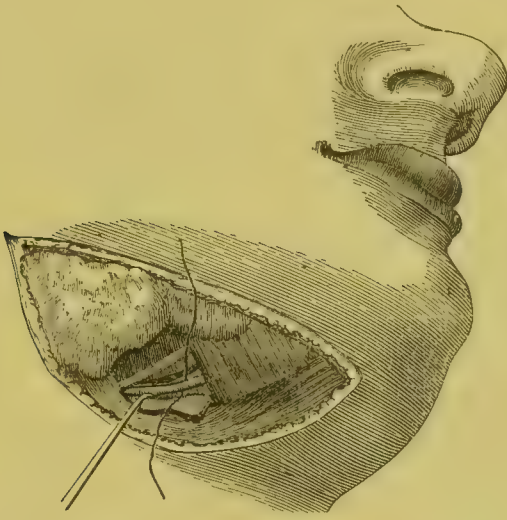
ing to the under surface of the tongue, it runs forward with a tortuous course to the tip as the ranine.

For practical purposes the relations of the artery may be subdivided into **three parts**—the **first** before it gets under the hyoglossus, the **second** while it lies beneath this muscle, and the **third** beyond this muscle.

In the **first** it runs very deeply, though only covered by the skin, platysma and fasciæ, facial, lingual, and some pharyngeal veins; it lies upon the middle constrictor, and the external laryngeal nerve.

In the **second part** of its course the artery again lies upon the middle constrictor, and is now covered by the hyo-glossus, hypoglossal, part of the mylo-hyoid and the lower border of the sub-

FIG. 132.*



The sub-maxillary gland is seen in the upper part of the wound. Below this is the hypo-glossal on the cut hyo-glossus. A ligature is passed between the lingual artery and vein. A hook depresses the great cornu of the hyoid bone. The lower part of the hyo-glossus is reflected. Lowest of all is the digastric.

maxillary gland. From this part come off the four branches of the artery, the hyoid at the outer or posterior edge of the hyoglossus, the dorsalis linguæ under this muscle, and the sub-lingual and ranine at its anterior border, thus allowing room for placing a ligature.

The **third part** lies in the mouth, and runs along the under surface of the tongue up to the point of the frænum. It is only covered by mucous membrane. A vein runs with it, and a large branch of the gustatory nerve.

Operations.

- i. Ligature under the Hyo-glossus.
- ii. Ligature of the first part of the Artery.

* The lingual artery is here drawn too large, and too much of the vessel is shown cleaned; the depth of the wound is not sufficiently represented.

i. The vessel is usually tied while under the **hyo-glossus muscle**, owing to the useful guide which the great cornu of the hyoid bone forms, and this is the operation which will be described here (Fig 132). Under some circumstances (p. 473) it will be needful to seek it nearer its origin from the external carotid. The parts being shaved, the head suitably supported and turned to the opposite side, and the lower jaw firmly closed, the surgeon, standing or seated on the same side, steadies the tissues between his left finger and thumb, and makes a curved incision with its centre just above the great cornu of the hyoid bone (a point previously carefully noted), and reaching, *e.g.*, on the left side, from just below and to the left of the symphysis downwards, backwards, and then upwards towards the angle of the jaw, ending just anteriorly to the line of the facial artery.

The incision divides skin, superficial fascia, and platysma; the deep fascia is then opened and any branches of the anterior jugular, facial, or communicating branch with the temporo-maxillary vein are secured carefully, so that the wound may be kept as dry as possible. The lower border of the sub-maxillary gland, which probably projects into the wound, is turned upwards* and the hypo-glossal nerve sought for, which lies deeper, and is a good guide to the hyo-glossus. Lower down in the neck is the glistening tendon of the digastric attached to the hyoid bone. The hyo-glossus being defined, the hyoid bone is carefully steadied by a finger-nail or tenaculum, a director passed under the hyo-glossus, and this muscle divided cautiously. In doing this the lingual vein must be carefully looked for either on the muscle or beneath it, with the artery. The artery having been found under the muscle just above the hyoid bone, it should be traced backwards so as to apply, if possible, the ligature behind the origin of the dorsalis linguæ. Adequate drainage must be provided, and every care taken to prevent decomposition in a wound so deep, and opening up several planes of deep cervical fascia.

Any enlarged glands will of course be removed.

Guides and Aids to finding the Artery.

1. A sufficiently free incision. 2. Carefully defining the hypo-glossal nerve, and remembering the relative position of the sub-maxillary gland, the digastric tendon, and the great cornu of the hyoid bone. 3. Keeping the wound bloodless.

Difficulties.

1. Matting of the parts from old cellulitis. 2. Presence of large veins. 3. Depth of the wound, and oozing low down from the severed hyo-glossus. 4. In one case Dr. Shepherd (*Annals of Surgery*, vol. ii. No. 11, p. 359) found the digastric so extensively tied down to the hyoid bone by the deep cervical fascia as to

* The sub-maxillary gland should be gently handled, and not cut into. Otherwise in the one case troublesome swelling, in the other temporary weeping of saliva, or even a fistula, will be the result.

require separation. 5. The position and condition of the lingual vein alike is at times perplexing. Usually it lies on the hyo-glossus; occasionally it lies under it, with its artery. Billroth (*Clinical Surgery*, p. 113), who has tied the lingual artery twenty-seven times, tied the vein for the artery in one case, as was verified post mortem. "Every surgeon knows the difficulty of tying the lingual artery in old people; the vessel lies so deep that it is very difficult to distinguish it from thick-coated distended veins, especially when, owing to heart-disease—as in this case—the veins pulsate. Never previously had I met with a lingual vein of such thickness." 6. Abnormal position of the lingual artery itself. This is rare, but the artery may lie higher than usual; it may pierce the hyo-glossus; occasionally, one lingual is minute or absent. 7. The sub-maxillary gland may be unusually large and occupy much of the space between the jaw and the hyoid bone.*

ii. If the vessel cannot be found on the hyo-glossus, or if the condition of soft parts is such, owing to cellulitis, matting, or enlargement of glands, as to prevent any attempt being made here, the surgeon must cut down upon the **first part** either by an incision similar to the above but less curved, and running from the centre of the hyoid bone just above the great cornu to the anterior border of the sterno-mastoid, or by one similar to that used for ligature of the external carotid, with its centre opposite to the hyoid bone.

Difficulties.

1. There is no certain guide to the artery here.
2. The artery itself is not constant in position here, varieties occurring frequently in the height at which it comes off from the external carotid, whether alone, or in common with the facial.
3. Large veins—*e.g.*, the lingual and facial—will certainly be present.

LIGATURE OF THE COMMON CAROTID

(Figs. 133, 134).

Indications.

1. Wounds of the trunk itself. Owing to the rapidly fatal issue of such injuries, the surgeon is not often called upon to meet them.† Cases calling for ligature for wounds of the trunk may be grouped as follows: (a) For immediate hæmorrhage; (b) for secondary hæmorrhage; (c) for gunshot injuries.

(a) *For Immediate Hæmorrhage.*—Ligature of the common trunk is here rarely called for, as above stated. In civil practice, such cases may occasionally occur in cut-throat. If the surgeon arrives in time, he should arrest the hæmorrhage, while waiting

* Dr. Shepherd, *loc. supra cit.*, p. 361.

† These, in reality, rare wounds of the common carotid might, at first sight, be thought to be more common, owing to the inaccuracy with which wounds of the external carotid have been quoted as those of the common trunk.

for assistance, by thrusting one or more fingers into the wound and making pressure on the bleeding point, remembering that but slight force is required if the pressure is on the right spot. If the patient has to be removed any distance, finger pressure must be kept up or the wound plugged with a carbolised sponge or aseptic gauze, and the head kept rigidly still. Pressure with a finger or with a sponge on a holder should be kept upon the bleeding point while the wound is enlarged, and the opening in the carotid secured by ligatures placed above and below it.

Mr. Butcher, in a case of suicidal cut-throat implicating the common carotid, successfully ligatured the artery above and below, the patient making an excellent recovery.

While on this subject, I may refer to the following case of Mr. Guthrie's (*Wounds and Injuries of Arteries*, p. 78), which shows that if the carotid is wounded, though not opened, it is best to apply ligatures above and below.

In a case of attempted suicide, the cut was deepest on the left side, having laid bare the left carotid and wounded the internal jugular. "The opening into the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and, drawing them together, passed a single silk thread around so as to close the opening without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and, after due consideration, it was presumed that this wound might heal without requiring a ligature to be placed upon the artery. On the eighth day arterial hæmorrhage took place, and, on opening the wound, it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common into the external and internal carotids. The hæmorrhage ceased on placing a ligature on the external carotid, and, as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness." At the autopsy the internal jugular was found pervious and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about $\frac{1}{4}$ inch with a soft clot, the wound in the common carotid was exactly below its bifurcation, and Mr. Guthrie thought that the ligature on the external carotid might have been sufficient.*

Mr. Guthrie mentions (*loc. supra cit.*, p. 79) another case in which the common carotid was wounded by a penknife, and the hæmorrhage arrested by tying the vessel above and below the wound.

(b) *For Secondary Hæmorrhage.*—A remarkable instance of punctured wound of the common carotid in which the vessel was tied for secondary hæmorrhage is thus recorded by Mr. Durham:†

A child aged nine was wounded with glass, owing to an explosion of hydrogen

* This would appear very doubtful, owing to the freeness of the collateral cerebral circulation, and the readiness with which a reflux current along the internal carotid is established.

† *System of Surgery*, vol. i. p. 739.

gas. When admitted into Guy's Hospital, under the care of Mr. Hilton, the child was cold and blanched, but the bleeding, which had been profuse, had entirely ceased. There was a wound about an inch long "in the left carotid region." On the eighth day after the accident hæmorrhage recurred, and the common carotid was tied. Nine days later slight bleeding took place, but was arrested by plugging the wound with sponge. Repeated epistaxis occurred, which weakened the child perceptibly. The sloughs became very offensive, but there was no further bleeding from the wound for eighteen days, when a considerable quantity was lost. The child gradually sank, and died six weeks after the accident.

At the autopsy the common carotid was found to have been traversed by a sharp-pointed fragment. Behind the wounded vessel was an abscess implicating the sympathetic. Mr. Durham thought that if a ligature had been applied on the distal as well as on the proximal side, the child's life would have been saved.

Another case of secondary hæmorrhage has been recorded by Mr. Rivington (*Trans. Med. Chir. Soc.*, vol. lxi. p. 63). This paper, like several others by the same writer, is replete with valuable information and interesting facts. It is an excellent instance of the way in which the carotid may at any time be wounded from within, and not from outside, by a foreign body penetrating the pharynx.

A boy, aged nine, six days after swallowing a small plaice-bone, was admitted into the London Hospital with stiffness and tenderness of the neck, a small tender lump on the left* side opposite to the cricoid cartilage, profuse salivation, and inability to swallow solid food. On the ninth and eleventh day hæmorrhage took place, on the latter occasion to half a pint. The following account of the operation by which the injured vessel was found and secured will be most instructive to every operating surgeon, owing to the difficulties which presented themselves :

An incision was made along the edge of the sterno-mastoid for several inches. The muscle was found glued to the subjacent parts by recent adhesions. Above the anterior belly of the omo-hyoid was a dark patch about the size of a four-penny-piece, caused by extravasated blood looming through the fascia. The fascia over the large vessels being divided, a probe was passed down into a cavity containing clot, hollowed out behind the vessels and on the inner side. Owing to the uniform discoloration of artery, vein, nerves, fascia, and areolar tissue by the extravasated blood, the structures met with, being all dark and equally stained, could scarcely be recognised. The *descendens noni* could not be seen, nor the *vagus* distinguished, though carefully looked for. More clots being turned out from the cavity, in one of these the fish-bone was found. A gush of blood which took place, evidently from the distal end, was arrested partly by pressure and partly by pulling forward the vessels with a blunt hook. The wounded vessel being found, a ligature was passed closely, as was thought, around it, both above and below the seat of injury. Owing to the danger of subjecting the patient to a further loss of blood, there was no time to make a prolonged dissection, and it was thought prudent to divide the artery at the seat of the wound to make sure that no branch was given off between the ligatures. When this was done, some nerve fibres were recognised on the cut section, and the question arose whether these were the *descendens noni* or the *vagus*. As they were in front of the vessel, closely adherent, and apparently scarcely numerous enough for the *vagus*, it was concluded that they belonged to the

* The left common carotid is more exposed to danger from the passing of the œsophagus somewhat to this side.

descendens noni, and no attempt was made to disengage the nerve or to unite its extremities. It was proved, later on, that this nerve was the vagus, which, instead of lying between and behind the artery and vein, took, or had been pressed into, an unusual position in front of the artery, and, owing to the inflammation induced by the injury, had become firmly adherent to the vessel for some little distance above and below the aperture in the artery. Externally the nerve was stained of the same dark colour as the artery, and only in the centre, after section, were the white nerve-fibres to be recognised. The patient died ten days after the operation, having shown no evidence of ill-effects from the divided vagus, save perhaps slight cough and difficulty in swallowing. Two gangrenous abscesses in the left half of the brain, which were probably already in progress prior to the operation, were the cause of death.

(c) *Division of the common carotid* by gunshot injuries is usually fatal at once, as in two cases recorded in Circular No. 3 of the War Department, Washington, 1871.

2. Aneurism of the carotid. When an undoubted* aneurism of the vessel exists and is increasing in spite of pressure,† or where this cannot be made use of, the artery should be tied, on the cardiac side of the aneurism if possible, or failing this, distally.

The Mortality after Ligature of the Common Carotid for Aneurism is as yet high. Thus Mr. Johnson Smith (*loc. supra cit.*), quoting from the tables of M. Lefort,‡ gives twenty-one as fatal out of forty-seven cases of proximal ligature. Mr. Barwell§ considers a little over 25 per cent. to be the mortality in cases of aneurism proper. Whichever of these estimates is correct, in the future the mortality should be much reduced by the advantages of aseptic surgery and modern ligatures. The chief dangers to be guarded against are suppuration of the sac and hæmorrhage, brain and lung complications, and hæmorrhage from the site of ligature. These are alluded to more fully below, p. 487.

The old operation for carotid aneurism is described at p. 487.

* It is well known that this aneurism is diagnosed more frequently than it is really found to exist, owing to the closeness with which some varicosity of the artery at its bifurcation, glandular and other tumours lying over it, and, in the root of the neck, other aneurisms—*e.g.*, of the innominate, aorta, and subclavian—simulate a carotid aneurism. Few surgeons will, I think, agree with the statement of Mr. Johnson Smith (*Dict of Surg.*, vol. i. p. 235) that carotid aneurism occurs "about as often as subclavian aneurism, and with greater frequency than aneurism of the axillary artery."

† This may be applied to the artery or the sac, or both. In the former case the artery should be compressed above the transverse process of the sixth cervical vertebra, to avoid making pressure on the vertebral at the same time. If pain, vertigo, sickness, &c., prevent a fair trial of digital pressure, an anæsthetic may be tried, but, as Mr. Barwell points out (*Encycl. of Surg.*, vol. iii. p. 498), there may be much difficulty in deciding how far the syncope, &c., which may be present are due to the anæsthetic or to the pressure. Another means of keeping up pressure on the common carotid is that suggested by Rouge, in which, the sternomastoid being relaxed, the surgeon insinuates his fingers behind one border, and his thumb behind the other border, of the muscle, and thus compresses the artery between them.

‡ *Gaz. Hebd.*, 1864 and 1868.

§ *Loc. supra cit.*, p. 503.

3. In aneurism of the innominate or aortic arch. The question of the advisability of ligaturing the carotid either together with the subclavian, or alone, especially in the case of the left common carotid, is considered at p. 537.

4. In orbital aneurism, where the symptoms are becoming aggravated, or where pressure has failed, or where it cannot be endured, even intermittently, for a few minutes only at a time, and where galvano-puncture and injection of coagulating fluids are set aside owing to their uncertainty and riskiness.*

Of the fifty-three cases (Rivington, *loc. supra cit.*), viz., twenty-one idiopathic and thirty-two traumatic, in which the common carotid was tied, thirteen of the former were cured and seventeen of the latter. The above writer, speaking of this mode of treatment, says it is "at present the most successful and satisfactory means of treating orbital aneurism. It should not be practised on patients advanced in years, or on those with heart disease, or evident atheromatous degeneration of arteries."

5. In aneurism of the external or internal carotid. These are very rare. Two cases of aneurism of the former vessel have been recently published:

Mr. Morris (*Med. Chir. Trans.*, vol. lxiv. p. 1), recorded one in which, after failure of ligature of the common carotid, the old operation of incising the sac was performed, and ligatures placed on the facial and lingual arteries, and upon the main trunk of the external carotid above the sac, with ultimate recovery.

The second case was published by Mr. Heath (*Ibid.*, vol. lxxxiii. p. 69) in order to prove that ligature of the common carotid alone is sufficient to cure some cases of aneurism of the external carotid.

The occurrence of aneurism here in a woman, aged twenty-three, was accounted for by the state of the cardiac valves and the liability for embolism to occur in consequence of detachment of a vegetation. There was a smooth, round, pulsating swelling just below the right mastoid process, reaching down to about the level of the upper border of the thyroid cartilage. It had the size and shape of half a small orange. The right tonsil was somewhat pushed inwards, the right temporal pulse was markedly weaker than the left, and the tongue deviated much to the right, the right half being a good deal wasted. The common carotid was tied and the wound healed, pulsation in the aneurism had stopped on the tenth day, and on the eighteenth the sac was smaller and quite hard. All seemed to be doing well till the thirty-third day after the operation, when loss of speech occurred somewhat suddenly, followed by right hemiplegia, and death on the thirty-fifth day, this being brought about by cerebral embolism taking place through the *left* carotid, the aneurism being solidified throughout.

Aneurism of the internal carotid is equally rare.

The following is a brief abstract of such a case (Dr. Wyeth, *Annals of Surgery*, August 1887, p. 114), in which the common and external carotids were tied, together with the superior thyroids, successfully.

* Mr. Rivington (*Dict. of Surg.*, vol. ii. p. 131) speaks thus of injection: "It is more painful than ligature, and probably involves more risk to vision, as it may set up inflammatory mischief in the loose areolar tissue around the veins, which may spread to the cornea. It may also effect so much coagulation as to interfere with the requisite supply of blood for the maintenance of the ocular tissues."

The internal trunk was affected with atheroma to such an extent that the ligature could not be applied to this vessel. The operation was performed July 24, 1883. The tumour rapidly diminished in size, the patient leaving the hospital on the twenty-ninth day after the operation. She is now living and well.

6. In hæmorrhage caused by ulceration of the throat after scarlet fever.

This is a rare but most dangerous complication of ulceration of the throat, and is usually brought about either by sloughing of the soft parts, or, as in the case mentioned below, by the opening of an artery or vein into an abscess cavity.

My old friend Dr. Mahomed communicated a case to the Clinical Society (*Trans.*, vol. xvi. p. 21) in which this complication occurred in a patient aged twenty-one. Secondary sore throat, after an ordinary convalescence, was noticed on the fifty-fourth day, with much swelling on the left side of the neck, followed by severe bleeding (to 40 ounces) from the mouth on the fifty-eighth day. The left common carotid was tied by Mr. Pepper on the fifty-ninth day. Five and a half ounces of pus were brought up soon after the operation, and the swelling of neck and pharynx subsided, a good recovery ultimately taking place.

The common carotid was selected for ligature in preference to the external, since it allowed the operation to be performed quite clear of the infiltrated tissues, and thus conferred a greater immunity from secondary hæmorrhage. Moreover, had the original bleeding come from the ascending pharyngeal, ligature of the external carotid might have failed to arrest it, as the place of origin of the former vessel is variable.

The next series of cases, 7 to 11, may call for ligature of the external carotid rather than of the common trunk. With reference to them it must be remembered that ligature of the common carotid must be resorted to, not, as has too often been the case, on account of the greater facility with which this vessel can be tied, but only when the state of the patient or the condition of the parts, either primarily, from an anatomical point of view, or, later on, after secondary hæmorrhage, do not admit of tying the external carotid itself.*

7. Incised or punctured wound near the angle of the jaw.

In these cases, as in those below, a correct diagnosis as to the vessel or vessels injured is by no means easy when a sharp weapon has passed obliquely and deeply behind the angle of the jaw. By such a wound either the external or the internal carotid or some branches of the former may be laid open. A careful dissection can alone clear up the source of the bleeding, and, whenever it is possible, this should be resorted to; where the circumstances do not admit of this, the surgeon, relying upon the extreme rarity of injury to the internal carotid from its protected position,† will

* In some of these cases the hæmorrhage may be arrested, and the dangers of tying the common carotid avoided, by the temporary closure of this vessel by a loop of stout catgut, applied as at pp. 501, 509.

† Mr. Cripps (*Med. Chir. Trans.*, vol. lxi. p. 235) shows that, out of eighteen cases in which the bleeding vessel was identified, the internal carotid was found only to have been wounded twice alone, and once in conjunction with the external.

be abundantly justified in tying the external carotid. Ligature of the common trunk is less reliable, though, if resorted to, on account of its simplicity, it may be defended by cases like those briefly alluded to by Mr. Le Gros Clark,* in which he successfully tied the common carotid for profuse arterial hæmorrhage due to stabs near the angle of the jaw.

"The injury was inflicted in the same way, and with the same form of instrument, in both instances—a pointed table-knife was plunged downwards and upwards behind the angle of the jaw. The bleeding was, in each case, controlled only by direct pressure with the fingers in the wound; and whilst this pressure was maintained I tied the artery. Not an untoward symptom accompanied or followed either of these operations."

On the other hand, cases of penetrating wounds near the angle of the jaw, ending fatally from hæmorrhage after ligature of the common carotid, will be found published by Mr. Travers (*Med. Chir. Trans.*, 1827, p. 165) and Mr. Partridge (*Lancet*, 1864, vol. i. p. 659).

8. Punctured wounds through the mouth.

Here, too, the common carotid has been tied in some cases successfully, while in others this step has been followed by repeated hæmorrhages and death.

The following case may be quoted as an instance of the former result:

A child fell while holding the sharp end of a parasol in his mouth, the point being thrust forcibly to the back of the fauces and very nearly coming through the skin at the side of the neck. Considerable hæmorrhage occurred at once, and also about a week later. Ten days later a gush of arterial blood followed on coughing. The common carotid artery was tied, and the case ended successfully.†

On the other hand, cases ending fatally after ligature of the common carotid for hæmorrhage after punctured wounds of the mouth will be found recorded by Mr. Vincent,‡ Mr. Arnott,§ and Mr. Marrant Baker.||

9. Hæmorrhage from carcinoma of the mouth—*e.g.*, tongue or fauces.

This subject is discussed at pp. 470, 495. It would be better surgery to tie the lingual in the case of tongue cancer, or, if the

* *Lectures on Surgical Diagnosis, Shock, and Visceral Lesions*, p. 222.

† The case was under the care of Mr. Johnson at St. George's Hospital. It is quoted by Mr. Durham, *Syst. of Surg.*, vol. i. p. 745.

‡ *Med. Chir. Trans.*, vol. xxix. p. 38. In this case the bifurcation of the right common carotid had been punctured by a bit of broken tobacco-pipe from within the mouth. Sloughy cellulitis set in, and hæmorrhage took place from the mouth a week after the accident. This was arrested by ligature of the common carotid, but recurred on the second, and again, fatally, on the fifth day after the operation. Mr. Vincent points out that if the bit of tobacco-pipe had been discovered and removed, fatal hæmorrhage must have followed instantly, as the artery was not only wounded, but plugged by the foreign body.

§ *Lancet*, 1864, vol. i. p. 135.

|| *St. Barth. Hosp. Reports*, 1876, p. 163.

growth be farther back, to tie the external carotid and ascending pharyngeal, and only, if this be found impossible, to ligature the common trunk.

10. Hæmorrhage after removal or incision of tonsils, or from an abscess about a tonsil.

These cases are infrequent, but, when they do occur, are, in many cases, most dangerous. The sources of the hæmorrhage are very numerous—viz., (1) One of the tonsillar arteries. (2) The tonsillar venous plexus. (3) The ascending pharyngeal. (4) The internal carotid. Hæmorrhage from the last two is much more likely to occur in suppuration in or around the tonsil than in wounds inflicted during operation on it.

The following is a good instance (Mr. Pitts, *St. Thomas's Hospital Reports*, vol. xii. p. 131) of a tonsillar abscess proving fatal from hæmorrhage :

A man, aged thirty-nine, was admitted with severe tonsillar abscess, which soon burst with the escape of a little blood. About 16 oz. were lost on the third day, bleeding again recurring on the fourth and fifth. The left common carotid was now tied ; thirty hours afterwards 22 oz. were lost, and the patient died.

There was an abscess cavity around the left tonsil which communicated with the left internal carotid by an opening the size of the little finger nail.

Mr. Morratt Baker has recorded a case of suppuration around the tonsil dating to an injury.

Here the vessel injured was the ascending pharyngeal, but too short a time elapsed between the ligature of the common carotid and the death of the patient to say whether the operation would have been successful.

A man, aged twenty-three, was admitted with symptoms of acute tonsillitis, the parts being tense, elastic, and prominent at one spot. A puncture was on the third day followed by the escape of blood. The patient now gave a history of having fallen two days before, when drunk, and having grazed his throat with a clay pipe ; this had been followed by very little bleeding. The temperature went up to 105°, and an arterial hæmorrhage occurred on the third day after admission. A probe passed through the puncture showed that a considerable cavity existed ; this was plugged with lint soaked in tr. ferri perchlor. The next day hæmorrhage recurred to half a pint ; when ether was given, the bleeding again came on, nearly suffocating the patient. On exploring the cavity with a finger-tip, a bit of clay pipe was withdrawn ; the cavity was again plugged and the common carotid tied. The patient died, without rallying, three hours later. A wound was found in the ascending pharyngeal artery.

Given a case of hæmorrhage from the tonsil (whether from a wound or an abscess) which resists other treatment, including well-applied pressure kept up with a padded stick inside the mouth and a finger behind the angle of the jaw, the surgeon should tie the external carotid as low down as possible, placing a ligature on the ascending pharyngeal as well, if this vessel can be identified. If the bleeding is from one of the tonsillar vessels it would be thus arrested, but in case the ascending pharyngeal is not secured, or the bleeding comes from the internal carotid, a loop of stout chromic gut should be placed as well under the to

the common carotid in the manner recommended by Mr. Livingston and Mr. Treves (pp. 491, 485).*

11. Hæmorrhage after operations on the neck or jaw. Hæmorrhage secondary to gunshot injuries.

In both these cases the parts may be so altered that it is quite impossible to find the bleeding point, and the soft parts may be damaged, matted together, &c., that the surgeon may be driven to tie the common carotid, and trust to this and to plugging the wound, rendered as aseptic as possible, with sal alembroth or iodoform gauze,† and firm pressure over all.

12. To arrest the growth of aneurism by anastomosis on the side of face, head, and neck.

The treatment of this condition is discussed at p. 492. It will be shown there that ligature of the external carotid cannot usually be looked upon as sufficient without other measures, owing to the free anastomosis between the branches of the opposite vessels. Still less is ligature of the common carotid likely to be successful, and this step should only be resorted to when ligature of the external carotid is impossible from the disease extending too low down, when, from its creeping towards the orbit, or to the back of the upper jaw, it is probable that there is free anastomosis between the branches of the external and internal carotid through the ophthalmic, or when the ascending laryngeal is sure to be involved, but this branch cannot be separately ligatured.

13. To arrest the growth of malignant tumours of the jaws which cannot be operated on, or which are recurrent.

This operation, first performed by Mott, is a very proper one in cases of malignant disease of the antrum, nose, &c., where the growth cannot otherwise be attacked and is growing very rapidly, causing frequent bleeding, intense pain, and threatening to interfere with deglutition and respiration. The surgeon must be prepared for a good deal of sloughing, fœtor, &c., as well as shrinking in very vascular growths which have begun to fungate. In this case, also, it will be a question as to whether it is wiser to ligature both external carotids or the common carotid. The cases given at p. 495 may help here. If the common carotid is tied, the opposite external carotid should be ligatured also, either at the same time or very shortly after, owing to the free anastomoses, which will bring blood over from the opposite side. In any case it should be an operation to be performed at the patient's request after the matter has been explained to him, in the hope that its performance may lead to relief from the urgent local symptoms of the growth, and that life may be brought to a close, after an interval of relief, by increasing, but less painful, asthenia.

* Every care should be taken throughout to keep the wound in the tonsil as aseptic as possible. As bearing on the use of iron perchloride as a styptic, see the remarks at p. 469.

† These may first be soaked in turpentine (p. 469).

LINE.—From the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

GUIDE.—The above line, and the inner edge of the sterno-mastoid.

RELATIONS.—The common carotids, as far as their relations in the neck go, extend from the sterno-clavicular articulation to the upper border of the thyroid cartilage, along a line from the above joint to a point midway between the jaw and the mastoid process.

IN FRONT.

Skin; fasciæ; platysma; superficial branches of transverse cervical, and anterior jugular.

Sterno-mastoid, sterno-hyoid, sterno-thyroid, omohyoid; sterno-mastoid artery.

Superior and middle thyroid veins.

Descendens cervicis.

Anterior jugular vein (below).

OUTSIDE.

Internal jugular (closer on left side).

INSIDE.

Pharynx.

Larynx.

Trachea.

Thyroid gland and vessels

Recurrent laryngeal.

Common carotid.

BEHIND.

Rectus capitis anticus major.

Longus colli.

Sympathetic.

Inferior thyroid artery and recurrent laryngeal.

Vagus.

Operation.—Two sites are usually described, according as the vessel is tied above or below the omohyoid.

A. ABOVE THE OMO-HYOID (Figs. 133, 134).—Also known as “the seat of election,” owing to the greater facility with which this operation is usually performed.

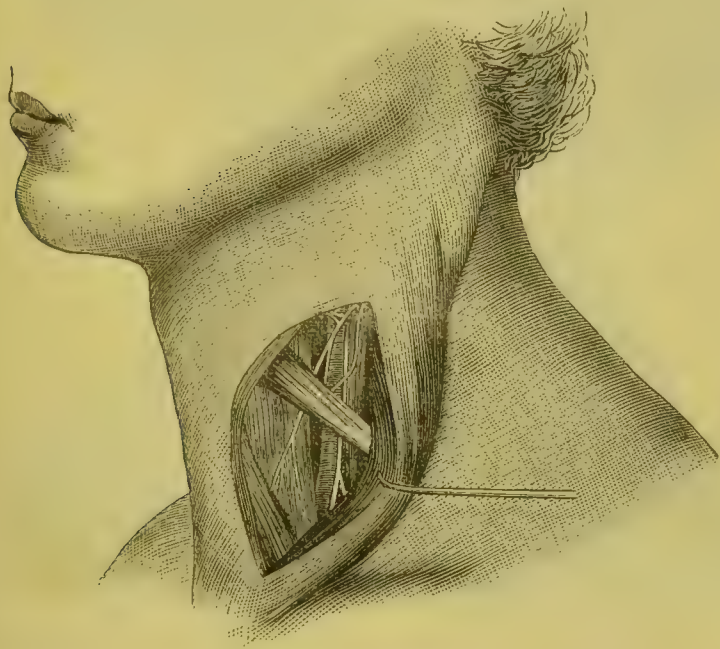
The parts being cleansed and shaved if needful, the shoulder are sufficiently raised, and the chin at first drawn a little upwards while the head is turned to the opposite side,* so as to define the anterior border of the sterno-mastoid.† The surgeon, standing

* Turning the head strongly to the opposite side should be avoided, as it brings the muscle over the artery. Mr. Barwell (*Encycl. Surg.*, vol. iii. p. 498) gives the following practical hint: “In certain aneurismal cases (aortic and innominate) the etherised patient cannot breathe while his head is thrown back; the anaesthetiser is obliged to insist on bending it forward, and the operator has to get at the vessel under very trying circumstances, since in that posture it lies much deeper, and the ramus of the jaw is terribly in the way.”

† Not always easy on the dead subject, or when the parts are infiltrated, as in Mr. Vincent's case (foot-note, p. 479), or in Mr. Rivington's (p. 475).

usually on the same side, makes an incision about 3 inches long, with its centre opposite to the cricoid cartilage, in the line of the artery, through the skin, platysma, and fasciæ, exposing the anterior border of the sterno-mastoid. Any superficial veins are now drawn aside, or tied before division with double catgut ligatures. The deep fascia at the anterior border of the sterno-mastoid is now divided, and the cellular tissue beneath opened up, usually bringing into view the upper border of the omo-hyoid, which, if in the way, is drawn down with a blunt hook, or divided.

FIG. 133.



Surgical anatomy of common carotid. (Maunder.)

The edge of the sterno-mastoid is now drawn outwards, and the pulsations of the artery felt for just below the omo-hyoid.* In clearing the tissues which remain over the vessel, troublesome hæmorrhage may arise from the superior and middle thyroid veins, especially if the respiration is embarrassed; more rarely the sterno-mastoid artery is cut, and requires a ligature. The sheath is next exposed, and opened well to the inner side, avoiding the descendens cervicis, which usually lies to the front and outer side of the sheath.†

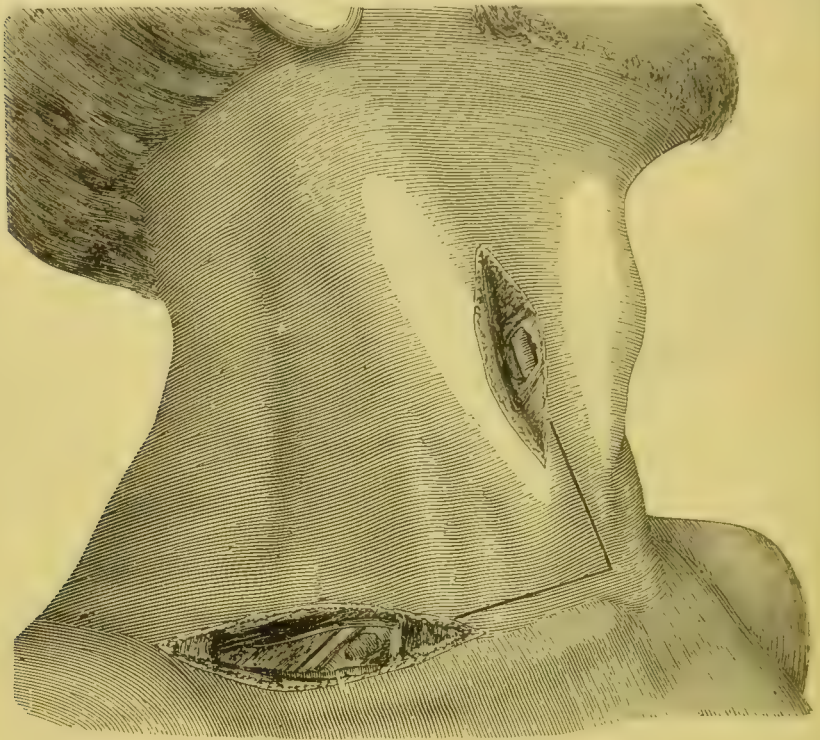
Other difficulties which may be now met with are an enlarged thyroid lobe overhanging the artery, or overlapping of it by the internal jugular when much distended. The coats of this vessel are so thin that, if it be much swollen, it is easily punctured, the result being that the wound is flooded with blood. It is best avoided by opening the sheath well to the inner side, but, if it

* This muscle should be drawn downwards, or divided if needful.

† The position of this nerve is, however, very irregular.

still give trouble, it should be drawn aside with a blunt hook, or pressure should be made on it by an assistant in the upper angle of the wound. If it should be opened, firm pressure should be made on this spot with a sponge on a holder, and the artery tied at a fresh place above or below. As soon as the ligature is tightened the hæmorrhage will cease, and firmly applied pressure outside the

FIG. 134.



In the ligature of the common carotid the only structures seen are the omo-hyoid, crossing the vessel below, and the superior thyroid vein above. Externally is a portion of the internal jugular, and more superficially the sterno-mastoid. The deep fascia is seen in the upper and lower angles of the wound.

In the ligature of the subclavian, the sterno-mastoid and the trapezius are seen in the angles of the wound. Above the vessel lie the cords of the plexus, crossed by two veins, probably the transverse cervical and the posterior scapular, coursing inwards to join the external jugular, which is seen at the inner part of the wound. Below the subclavian artery is seen a portion (too much is shown) of the supra-scapular artery.

The angular incision shows that for ligature of the innominate, the first part of the subclavian, and, in cases of difficulty, the first part of the carotid.

wound for forty-eight hours will suffice to prevent any recurrence. If, after wounding the vein, attempts are continued to tie the artery at the same place, the wound in the vein is almost certain to be made larger. Other methods are to pinch up the wound in the vein and tie up the opening (if small) with fine carbolised silk or chromic catgut, or to leave on compression-forceps (p. 451).

The sheath having been opened well to the inner side with a careful nick of the knife, the artery is now cautiously and suffi

sufficiently cleaned, the inner edge of the sheath being held with forceps while this side of the vessel is cleaned, and then the outer in the same way, and, finally, the posterior aspect, the point of the director being kept most scrupulously in contact with the vessel here.* The needle is then passed from without inwards, being kept most carefully close to the artery, especially behind, so as to avoid including the vagus.

In this as in every other artery whose relations are important, the fewer of these relations that the surgeon sees the more masterly and successful will his operation be.

In a deeply lying artery, in addition to relaxing the parts by flexing forward the head and depressing the chin, the sterno-mastoid must be drawn outwards and the larynx inwards with retractors, while the omo-hyoid is drawn downwards with a blunt hook, or divided. The pulsation of the artery is then felt for, or, where this is feeble or absent, the rolling of the artery as a flat cord under the finger is made out.

B. LIGATURE BELOW THE OMO-HYOID.—Here the artery lies much deeper, and has the recurrent laryngeal nerve behind it: on the left side, the internal jugular vein lies very close to the artery; on the right, there is a distinct interval between the two vessels.

The patient's head and the operator being in the same position as at p. 482, an incision 3 inches long is made in the line of the artery from below the cricoid cartilage to just above the sterno-clavicular joint, exposing, as before, the anterior edge of the sterno-mastoid. This is drawn outwards, and, if needful, divided or detached below by making a short incision outwards along the clavicle. In this case the anterior jugular vein must be carefully looked for as it passes outwards in the root of the neck under the sterno-mastoid. The depressors of the hyoid bone next come into view; of these the sterno-hyoid, overlying the broader sterno-thyroid, is certain to be seen. If the omo-hyoid is coming up at this level, it lies external to the others. In such case it is to be drawn out while the other two are pulled inwards, any of the three being divided, on a director, if needful. At this stage one or more of the inferior thyroid veins may come into view, much swollen. The pulsation of the artery being felt for, or the flattened artery felt slipping beneath the finger when pressed upon, the sheath is to be opened well to the inner side, retractors usually being required at this stage. Care must be taken of the internal jugular, especially on the left side, as, if distended, it may conceal the artery (p. 483).

When the carotid is sufficiently cleaned, the needle is passed from without inwards, avoiding the recurrent laryngeal nerve behind by keeping very close to the artery.

Temporary Ligature of the Carotid.—Mr. Rivington (p. 492) and Mr. Treves (*Lancet*, January 21, 1888, p. 111) have drawn

* Opening the sheath on the inner side and cleaning the vessel properly are the two best safeguards against accidents.

attention to this method, believing that the ligature of main arteries is resorted to too often, as there is sufficient evidence to show that in most cases it is only temporary arrest of the current that is required.

This method should certainly receive a further trial, on account of the risks of cerebral mischief after ligature of the carotid, and also because, as Mr. Treves says, pressure upon the carotid cannot be successfully maintained for a serviceable length of time.

The artery being exposed in the ordinary way, a thick piece of soft catgut is passed round it and tied in a very loose loop. By pulling on the loop, the blood-current is at once arrested, and restored when the tension is relaxed.

The following are abstracts of the four cases given by Mr. Treves :

1. Probable Wound of Superior Thyroid Artery.—A young man was admitted with a deep, profusely bleeding wound about the level of the great cornu of the hyoid. A fragment of glass driven in by a bursting soda-water bottle had been removed. The patient was blanched and almost insensible. It being "obviously useless to attempt to find the bleeding point while blood was welling up from so deep a wound," Mr. Treves placed a temporary ligature round the common carotid. Traction on this arrested all bleeding, and was maintained for half an hour. On relaxing the catgut, no hæmorrhage occurred. The loop was left *in situ* for four days, and then removed. The bleeding was supposed to come from the superior thyroid.

2. Hæmorrhage from Internal Carotid.—A child, aged three, had profuse hæmorrhage from the right ear, and vomited blood. This recurred, and the right common carotid was ligatured, and the bleeding ceased. The next day the same hæmorrhage recurred, having evidently been brought round by the left carotid. As there is no case on record* of recovery after ligature of both common carotids

* I am indebted to Dr. Simpson, Surg. Capt. Ind. Med. Service, for the following very interesting case, which has an important bearing on the above statement. Case of Resection of Right Upper Jaw for Sarcoma with Ligature of both Common Carotids.—The patient was a Telegu lad about eighteen years of age, admitted into the Madras General Hospital while Dr. Simpson was acting as surgeon. Prior to operation the right common carotid was tied with the view of diminishing the hæmorrhage at the operation. One week elapsed between the ligature of the artery and the removal of the jaw. During that interval Dr. Simpson and Dr. Smyth came to the conclusion that there would be no immediate danger in occluding the other common carotid, if need arose. Dr. Simpson began the operation (on the eighth day after ligature of the right carotid) by exposing the left common carotid at the level of the cricoid and passing a piece of elastic tubing round it. This was tightened gently and produced no effect upon the patient, who was well under the influence of chloroform. With the assistance of Dr. Smyth, Dr. Simpson removed the jaw, this being done almost bloodlessly. On relaxation of the tubing, sharp hæmorrhage ensued. In preference to attempting to arrest this, and thus causing much delay—a matter of great importance—a ligature was substituted for the tubing and the artery was tied. The patient made an uninterrupted recovery and six months later was known to be in good health. There seemed danger at first of sloughing along the lines of separation of the jaw, and irrigation was constantly employed for the first two or three days. The case will be found published in the *Trans. South Indian Br. Brit. Med. Assoc.*, vol. v. No. 3.

when the interval between the occlusion of the two vessels was less than some weeks, Mr. Treves simply placed a loop of catgut round the left carotid, and had traction made on it. The child never bled again, but sank exhausted six days after the second operation.

3. *Hæmorrhage* probably from External Carotid, after Impalement with a Spike.—A man, aged forty-one, fell 26 feet upon a railing-spike, which, entering just in front of the left ear, passed through the upper jaws, and entered the mouth through the hard palate on the right side. After removal of the spike, blood welled up freely from the wounds and nose. Traction made on a catgut loop passed round the common carotid arrested this. A weak pulse could be felt in the temporal on the fourth day, and on the seventh the loop was removed. The case did well. It is not stated how long traction was maintained.

4. *Hæmorrhage during an Operation*.—In this case the loop was placed around the artery prior to removing a large malignant tumour of the neck. Very free bleeding occurred during the operation, but was always checked by traction on the loop. Without this the operation would have been very difficult.

Old Operation for Ligature of the Common Carotid.—This, perhaps the most formidable operation in surgery, was successfully made use of by Prof. Syme (*Observ. in Clin. Surg.*, p. 154) in a case of aneurism the result of a stab.

The aneurism, about the size of an orange, extended between the trachea and sterno-mastoid, and downwards close to, or rather under, the clavicle. Nearly at its centre was a cicatrix. It was increasing in size, and, other treatment having failed, it was decided to perform the old operation, it being evidently impossible to apply a ligature below the aneurism.

"I pushed a knife through the cicatrix, and followed the blade with the forefinger of my left hand so closely as to prevent any effusion of blood. I then searched through the clots and fluid contents of the sac for the wound of the artery, and found that pressure at one part made the pulsation cease. Keeping my finger steadily applied to this point, I laid the cavity freely open both upwards and downwards, turned out the clots, and sponged away the blood so as to get a view of the bottom, which presented the smooth, shining aspect of a serous membrane, without the slightest indication of either the artery or vein that could be seen or felt. In order to make the requisite dissection, I next attempted to close the orifice by means of forceps, but found that it had the form of a slit, which could not be thus commanded. It was also so near the clavicle that pressure could not be employed below it, and, to my still greater concern, lay on the inner or tracheal side of the vessel, so that the compression required for its closure, instead of being backwards on the vertebræ, was outwards upon the vein. In these circumstances it seemed proper, so far as possible, to lessen the opposing difficulties, and I therefore ran a bistoury through the skin and the sternal portion of the sterno-mastoid. I then seized the edge of the slit in the artery, as it lay under my finger, with catch-forceps, and desired them to be held so as to draw the vessel towards the trachea; I then carefully scratched with the point of a knife until the arterial coat was brought into view at its external edge, a little above the aperture, where a ligature was passed by the needle, and tied. I repeated the same procedure below the wound, and, when it was completed, had the satisfaction of finding that my finger could be withdrawn without the slightest appearance of bleeding, instead of the tremendous gush which had previously attended its slightest displacement. The ligatures separated on the tenth day, and the patient recovered completely."

Prof. Syme considered this by far the most arduous operation he had undertaken, from the fact that "the slightest displacement of one hand must have instantaneously caused a fatal hæmorrhage

from the carotid artery, and a wrong direction of the needle by the other, to the smallest possible extent, would have given issue to an irrepressible stream from the jugular vein."

Sir J. E. Erichsen * gives the following graphic picture of the difficulties of the operation :

The hæmorrhage having been completely arrested, either by compression of the artery above the tumour, or by pressure of the fingers at the opening leading into the tumour,† you lay it open freely and completely, turn out the coagulum and syringe away any dark or fluid blood which may be there. You then open the interior of the aneurism. But what is that interior? It is not the interior of a smooth sac, but it is a large ragged cavity with masses of coagulum or solid fibrin sticking to it in different directions, with the remains, perhaps of an old sacculated aneurism at the bottom, with a quantity of plastic matter infiltrating the tissues around it, with the anatomical relations of the parts utterly and completely disturbed and destroyed, with great thickening and solidification of the parts around from the pressure to which they have been subjected in consequence of the effusion of plastic matter. So you have a large cavity with an opening at the bottom of it, the opening leading to the artery somewhere or other, but the position of the artery more or less disturbed, more or less masked and obscured by these masses of coagulum, by this plastic infiltration, by this thickening and cohesion of the tissues to one another around it. The next thing is to pass the ligature around the artery. Now, the artery does not lie exposed in this sac: quite the contrary. You have to scrape, or to dissect, or cut through the posterior wall of this sac, which always overlies the artery. That constitutes the great difficulty of the operation—to open up this posterior wall in a proper direction, and to get the needle round the part without wounding the contiguous vein, or transfixing the artery, or doing damage to the neighbouring parts. The best way of doing that, undoubtedly, is to introduce a large steel probe or a metallic bougie into the opening into the artery, and to use that as a guide to the situation of the vessel. You may use a large one so as to plug up the opening.‡ You then clear the vessel as well as you can—the coats are generally thickened and diseased in the vicinity of the aneurismal tumour—and you pass a good double ligature around it."

Difficulties and Possible Mistakes during Ligature of the Common Carotid.

(1) Altered condition of the soft parts—*e.g.*, matted and œdematous from the close contiguity of an aneurism, from a previous trial of pressure; or loaded with blood or inflammatory products, as in the case of a wound. (2) Presence of an aneurism encroaching upon the incision. (3) Not hitting the edge of the sternomastoid. This muscle may be drawn over the artery if the chin be too much forced to the opposite side. The chin should be kept

* *Lancet*, 1868, vol. ii. p. 505.

† Sir John thus puts Prof. Syme's practical point—"to make a small opening into the tumour, an opening just sufficient to enable you to insinuate your fingers, and so to work your whole hand gradually into the tumour in that way, so that the entrance of the hand may plug up the opening into the sac; to feel with your fingers for the opening into the artery, and to get your fingers against that, so as to restrain the flow of blood from it, before the rest of the sac is laid open."

‡ In one case, as stated by Sir John, Mr. Birkett used a bougie as a guide.

bout midway between the acromion and the episternal notch on the opposite side (Barwell). (4) Great enlargement of the superior and middle thyroid veins.* (5) An enlarged and overlapping thyroid gland. (6) A large internal jugular overlapping the artery. (7) Opening the sheath towards its outer side, and so coming down upon, and perhaps injuring the vein.† (8) Including one of the nerves,‡ in relation with the artery—*e.g.*, the descendens cervicis, the vagus, or the sympathetic (p. 475).

Causes of Failure and Death after Ligature of the Common Carotid.

I. Cerebral complications—*e.g.*, impaired nutrition and softening. Sir J. E. Erichsen thinks that "cerebral symptoms" (he does not say whether he means fatal ones or no) are liable to occur in 25 per cent. of ligatures of the common carotid. They may come on almost at once, or some days after the operation. The same surgeon divides them into two sets—(1) the early ones, resulting from the too small supply of arterial blood, viz., syncope, twitchings, giddiness, impaired sight, and hemiplegia; (2) after the above have been present for a few days, and softening has taken place, convulsions and death ensue.§ It would be, perhaps, worth while, in view of the above mortality, to try pressure before resorting to the ligature, in order that the opposite vessels may become enlarged. Pressure could only be kept up, without an anæsthetic, for a few minutes at a time, and care would have to be taken not to apply it at the intended site of ligature. The temporary ligature (pp. 485, 492) also deserves

* Mr. Barwell (*Intern. Encycl. Surg.*, vol. iii. p. 499) says that the superior thyroid vein, very full and turgid, sometimes runs before, more often behind, the carotid. "I suppose it is the effect of the anæsthetic which causes this to swell to the size of a cedar pencil."

† On the dead body, especially, there is a risk of mistaking the flaccid jugular for fascia, and opening it, unless the sheath has been opened over its front and inner part, as should be always the practice.

‡ "The descendens noni lies usually on the outer part of the sheath, and will rarely be endangered if that structure is opened as above described; but it is well to see that it is out of the line taken by the director; if its absence there be verified, it need not be hunted up elsewhere. The pneumogastric lies in the interval between the artery and vein in the back part of, but not loose in, the sheath; each of the vessels, as well as the nerve, has a compartment, strongly walled, to itself; while the sympathetic, behind the sheath, is also separated by a thick fascia from the vessels. If these anatomical positions be maintained, both nerves are safe. Young operators are sometimes made anxious and embarrassed by unnecessary cautions, yet sometimes the parts do not quite maintain their proper positions. Hence it is well, before tightening the ligature, to see that it includes the artery only."—BARWELL (*loc. supra cit.*).

§ Mr. Barwell (*loc. supra cit.*) argues, from the fact that in no case of ligature of the innominate—an operation which cuts off all the right blood-supply—have cerebral symptoms supervened, that there must be some other cause than brain anæmia for these complications: he thinks that a large majority of the cases in which so-called cerebral symptoms supervened from the seventh to the tenth day were cases of pyæmia, and that in some cases detachment of minute portions of clot may have been the cause.

trial. 2. Cellulitis and septic complications. 3. Recurrent pulsation. In most cases this is due to blood finding its way round from the opposite side. The pressure, however, in cases of aneurism, having been relieved, coagulation, as a rule, takes place though slowly. In a smaller number of cases the recurrence of the pulsation has been of a more permanent kind, from the ligature becoming loosened or dissolved, especially when catgut has been used. 4. Suppuration of the sac. Sir J. E. Erichsen states that this is not very uncommon. "In the majority of cases the patient eventually does well." 5. Hæmorrhage. This has never been a common complication, owing to the absence of branches. It may take place from the site of ligature* or from a suppurating sac. It should be still more rarely met with in the future, owing to the modern treatment of wounds. 6. Low forms of lung inflammation. The above authority states that these are not uncommon. He attributes them to diminished freedom of the respiratory movements owing to the disturbed circulation in the brain and medulla.

LIGATURE OF THE EXTERNAL CAROTID (Figs. 136, 137).

This operation has not received the attention which it deserves, having been too often set aside for the easier operation of ligature of the common trunk.

Mr. Cripps,† discussing the ligature of the external carotid in the treatment of hæmorrhage from punctured wounds of the throat and neck, states that the objections raised to the above operation are :

1. The fear of secondary hæmorrhage from the seat of ligature due to the close proximity of its larger branches.

In answer to this he refers to M. Guyon's‡ collection of 27 cases of ligature of the external carotid, to which he adds 3. In only one case of these 30 did secondary hæmorrhage occur. Larger statistics than these have been furnished by Dr. Wyeth, of New York. He states that, of 67 cases in which the external carotid alone was tied, 3 died, and that all these fatal cases were from gunshot injuries in military practice. One of these fatal cases died on the table from the effects of hæmorrhage before the ligature could be applied. In the other 2 the cause of death is not given. Of the 67 cases, hæmorrhage occurred after ligature in 5, none of which proved fatal. In 4 of these the bleeding was noted as occurring at the seat of lesion beyond the ligature. The artery was tied on both sides in 2 patients, and both recovered.

* This danger would seem to increase the lower down the ligature is placed. Mr. Barwell says that the only fatal case of secondary hæmorrhage he has had in this operation followed the ligature of a carotid with catgut close above the sterno-clavicular joint. It is not stated whether the wound was aseptic throughout or not.

† *Med. Chir. Trans.*, vol. lxi. p. 234.

‡ *Mém. de la Soc. de Chir.*, vol. vi. According to Prof. Agnew (*Prin. and Pract. of Surg.*, vol. i. p. 636), out of nineteen cases of ligature of the external carotid only one proved fatal from hæmorrhage, and none from causes which could properly be attributed to the operation.

Dr. Bryant, of New York,* states that he can add 16 cases to the above 67, and that in only one of these did the subsequent death bear the least relation to the operation itself.

2. The futility of the operation, should the wounded vessel be the internal carotid.

Mr. Cripps answers this objection by comparing the rareness of a wound of the internal carotid with one of the external or its branches.

He points out that, of eighteen cases in which the bleeding vessel was identified, the internal one was wounded twice alone, and once in conjunction with the external.†

3. The external carotid is less easy to ligature than the common. This objection will not weigh with a surgeon who knows his anatomy, and who is in the habit of operating.

The **advantages** of the operation are:

1. That the circulation through the brain is not in the least interfered with. Consequently, one large element of danger is avoided (p. 489).

2. The incision made over the external carotid can also expose the bifurcation and the internal carotid, and may thus lead to a direct exposure of the wounded vessel.

Indications.

i. Wounds of the Trunk and of its Branches.—This subject has been already alluded to (p. 478). While it cannot be denied that the easier operation of ligature of the common trunk has answered in some of these cases, it has also certainly failed repeatedly. Considering the rarity of wounds of the internal carotid, the surgeon will do more wisely, in the case of a wound over the carotid area, to expose and tie the external carotid low down, in any cases of doubt, that the trunk and the internal carotid may be exposed as well, if needful.

Mr. Rivington has recorded (*Clin. Soc. Trans.*, vol. xvii. p. 79) an interesting case of a wound of the external carotid by a stab in the parotid region giving rise to recurrent attacks of hæmorrhage, and treated successfully by temporary‡ ligature of the

* *Ann. of Surg.*, August 1887, p. 122. In this fatal case both external carotids had been tied to check the rate of progress of malignant disease of the lower jaw, floor of mouth, and tongue, which had been operated on repeatedly without success.

† Mr. Cripps' list is interesting to the surgeon. In the first 10 it is to be presumed that ligature of the external carotid would have been the wiser course. In 2 the bleeding came from the external carotid; in 1, the lingual; in 1, the facial; in 1, a tonsillar branch; in 1, a branch in the parotid gland; in 2, the internal maxillary; in 1, the inferior dental; in 1, the middle meningeal; in 1, the vertebral; in 2, the internal carotid; in 1, the external also was wounded; in 1 the source was close to the bifurcation; in 2 the common carotid, at the point of bifurcation, was wounded; in 1, the ascending pharyngeal.

‡ Some cases in which Mr. Treves has more recently made use of this step are given at p. 486.

common carotid and ligature of the external carotid at the seat of injury.

A man, aged thirty-one, was admitted into the London Hospital with three wounds, one severing the lobule of the left ear and passing into the parotid gland below the zygoma, a second behind the ear, and a third over the mastoid process. Hæmorrhage, occurring about a week later, was stopped by pressure. Erysipelas followed, and an abscess was opened in front of the ear. About three weeks after the accident, hæmorrhage again occurred, being brought on by a fit of coughing, blood running out from all the incisions. Though it was again arrested by pressure, Mr. Rivington judged, from the size of the stream and the force of the jet, that the injured vessel must have been the external carotid in the parotid gland.

On account of the difficulty of securing the artery at the seat of injury, and the amount of blood which would be lost before this could be accomplished, and not being able to rely upon pressure on the common carotid during the operation, Mr. Rivington cut down first on the common trunk at its bifurcation and placed a temporary ligature of catgut round it,* tying this lightly so as to stop the current of blood, but not to divide the inner and middle coats.

The openings in the parotid region being explored and clots turned out, a little below the angle of the jaw was found a hole from which some blood issued in a feeble stream. The external carotid was ligatured above and below this spot. The ligature in the main trunk was then untied, and left *in situ* for use if needed. All bleeding had ceased, and there was no recurrence. The patient made a good recovery, some weakness of the face muscles having almost disappeared when he left the hospital.

Mr. Rivington draws attention to the advantage of the temporary ligature on the main trunk, rendered very evident by the fact that immediately before the operation, when the sponge was removed, arterial blood spurted out in a lively jet, whilst after the ligature a languid stream only issued, from the distal side of the hole in the external carotid. He further points out that the employment of temporary ligatures, either lightly tied or left *in situ* for use in case of need, is capable of wider application in the treatment both of hæmorrhage and of aneurisms.

ii. Aneurism by Anastomosis of Scalp and Side of Head and Neck (Fig. 135).—Here the ligature of the external carotid should only be made use of as an adjunct to local treatment, or where this has failed.

If the growth is not too large, it should be excised with anti-septic precautions, tying each vessel as it is cut. The operation may be rendered partly, if not entirely, evascular by the use of stout india-rubber bands passed round the back of the head and the lower jaw, with pledgets of lint over the main vessels—*e.g.* temporal or external carotid, posterior auricular, and occipital. Another method is one made use of by Mr. Hutchinson in the removal of an enormous fibro-cellular tumour of the scalp—*viz.*, a Petit's tourniquet passed around the back and sides of the head and lower jaw (p. 162).

* It remained uncertain whether this temporary ligature was placed on the external or the common carotid.

If the above are not applicable, the external carotid may be tied preliminary to removing the tumour. When this is being effected, any skin that is not too much involved should be preserved. If this is impossible, the growth must be taken away, with the skin over it, the vessels being secured as cut. Every means must be taken to keep the wound aseptic, and thus promote rapid granulation-healing, completed by skin-grafting.

If excision is not feasible, the main vessels of supply should be under-run with pins, in order to bring about their closure and, ultimately, the obliteration of the growth.

The case from which Fig. 135 is taken was that of a woman, aged twenty-two, who was thus treated by Sir W. Fergusson (*Pract. Surg.*, 4th edit. p. 162, Fig. 73):

FIG. 135.

The common carotid had been previously tied by Mr. Storks, but the vessels slowly increased in size. Long needles were passed under and through the vessels at the most prominent points, being sufficiently strong to bear the pressure, made by twisting strong threads about them over the included vessels and scalp. At some points sloughing occurred; elsewhere ulceration loosened the needles. In about three weeks, as anticipated, hæmorrhage took place. Digital pressure was made use of till fresh needles were introduced and the old ones withdrawn, when threads were again applied, and the bleeding arrested. Further inflammation and obliteration of the vessels ensued, repeated hæmorrhages were arrested in a similar manner, the formidable affection being ultimately completely obliterated.



(Fergusson.)

In a similar case it would probably be wiser to tie the external carotid before inserting the pins.

The following case, published by Mr. Wood (*Lancet*, 1881, vol. ii. p. 255); is an excellent instance of the same treatment, aided by the antiseptic advantages of the present day:

A man, aged thirty-seven, had a pulsating tumour in the right parietal region, of the size of a hen's egg, with a bruit, together with a pulsating swelling running forwards to the left orbit, the eyeball being pushed forwards, while a loose, pulpy, nævoid condition extended into the occipital region. With antiseptic precautions, stout steel pins were run under the right supra-orbital, temporal, and occipital arteries. The left occipital and temporal had to be occluded before the pulsation stopped, and four pins were also passed under the swelling itself and in its neighbourhood. The pins were passed quite down to the bone, and

were made to emerge clear beyond the vessels. These were compressed with silk over thick india-rubber pads, which served to tighten up the pressure as the pins cut through. About an hour after the operation intense neuralgic pain in the occipital region was experienced from inclusion of the nerve. The antiseptic precautions were stopped in ten weeks, and the patient was quite cured without any bleeding, suppuration, or sloughing, save, to a very limited extent, at one spot.

As these cases are most obstinate, my readers will excuse me if I draw their attention to another case proving that ligation of the external carotid (even if performed on both sides) is no likely to be successful without local treatment as well—viz. either under-running the vessels with pins, or excision. It is recorded by Dr. Bryant, of New York (*Annals of Surgery*, August 1887, p. 116):

The patient, aged twenty-four, had a well-defined pulsating tumour at the site of a healed scalp-wound in front of the left ear. The trunk and branches of the temporal and the occipital were concerned in the growth. As this was rapidly increasing, the left external carotid was tied with catgut about half an inch above its origin. Tying the lingual artery also provided a branchless portion of the external carotid about an inch in extent. The ascending pharyngeal was sought for, but not found. All pulsation was at once checked, and the growth was also reduced to about one-third of its previous size. The operation was antiseptic throughout, and when the dressings were changed for the first time in ten days, a slight return of pulsation was noticed in the tumour. A month after the operation, pulsation, thrill, and bruit were nearly as strong as before, and it was decided to attack the tumour itself in preference to tying the occipital and temporal branches, or the right external carotid. The arterial circulation was admirably controlled by surrounding the head with two strong rubber bands, beneath which compresses were placed at the points where arteries passed to supply the scalp.

Dr. Bryant has found eight other cases of ligation of the external carotid for the cure of aneurismal tumours of the head, face, and parotid gland, in two of which both the vessels were tied simultaneously. This latter procedure is not reported to have been successful in either case. Of a total of nine cases, only one, a traumatic aneurism of the parotid, was cured by ligation alone.

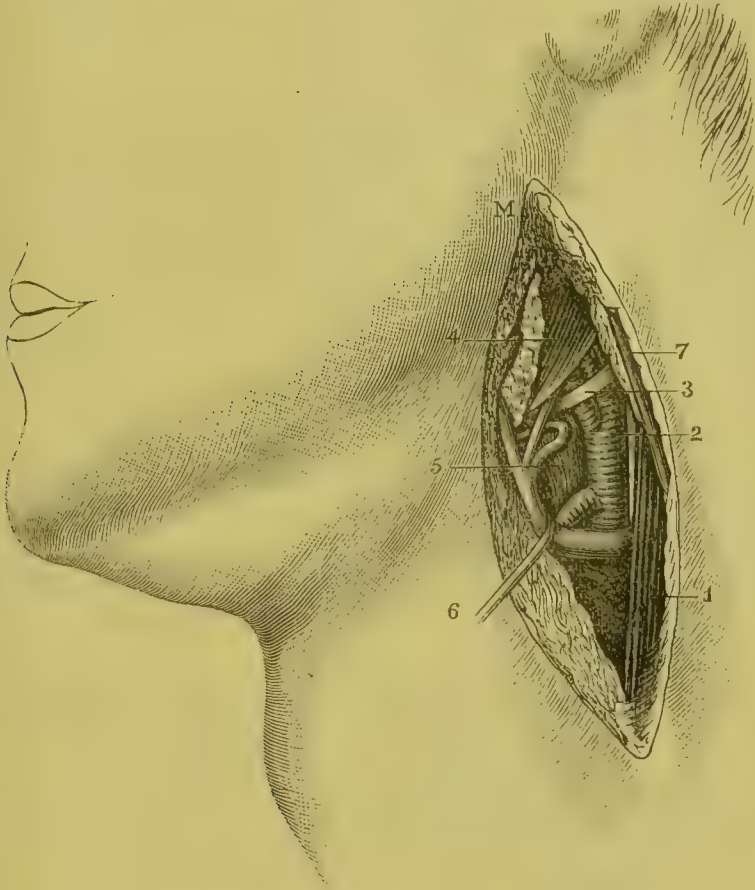
Thus it would appear that local remedies—viz., excision and under-running, aided by ligation of the chief feeding arteries—are most likely to be successful in this disease, which so often baffles treatment. Ligation of the external carotid, on one or both sides, will fail, owing to the free collateral circulation, if tried by itself, even in recent traumatic cases without much general dilatation of the vessels. If used at all, it should be so as an adjunct and a preliminary step to diminish the vascularity of the tumour before this is dealt with locally by the methods above indicated.

iii. Aneurism of the External Carotid.—The treatment of this rare condition has been already discussed at p. 477.

iv. As a Preparatory Step to extirpating Malignant Tumours of the Upper Jaw, Pharynx, &c., or as a Palliative Step where the above Extirpation cannot be attempted.—This question has already been discussed at p. 481.

The following cases (Dr. Bryant, *Ann. of Surg.*, August 1887, p. 121) are of interest as bearing on this matter. In each of these cases repeated operations had been performed for removal of malignant disease involving the lower jaw, floor of the mouth, and more or less of the tongue. Rapid recurrence had taken place in each case, until, the use of the knife no longer appearing feasible, the only course seemed to be starvation of the growth. Accordingly, this was attempted by simultaneous ligature of both the external carotids, by incisions in the usual place, the enlarged lymphatic glands found being removed. When the

FIG. 136.



Parts concerned in ligature of the left external carotid dissected. M. Angle of the mandible. 1. Anterior border of sterno-mastoid. 2. Descendens cervicis. 3. Hypoglossal. 4. Posterior belly of digastric. 5. Lymphatic gland displaced from its position over the artery. 6. Venous trunk common to the superior thyroid, lingual, and facial, hooked downwards so as to show the spot to be chosen for the ligature, viz., between the origins of the superior thyroid below and the lingual and facial above. 7. External jugular vein descending from the parotid gland in the upper angle of the wound. (Farabeuf.)

Carotids were reached, most unusual anomalies were found. The right common carotid bifurcated beneath the posterior belly of the digastric, which was divided to admit of passing the ligature. On the left the bifurcation was behind the hypoglossal nerve, which was drawn down, and the ligature then passed just below the digastric. The lingual and facial branches were not seen on the right side, but this caused no apprehension, as the facial was said to have been tied some months before, during removal of the diseased sub-maxillary gland on that side. On the left side the branches of the external carotid were normal. The

operations were antiseptic throughout. The malignant growth diminished in size rapidly, the discharge became scanty, thin, and watery, and the ability to speak and swallow improved quickly. On the fifth day a portion of the growth on the right side sloughed out, leaving an aperture bounded by sloughy tissue, at the bottom of which could be seen necrosed bone in the lower jaw. Nine days after the operation profuse hæmorrhage took place, with a fatal result. This hæmorrhage was caused by sloughing of some of the diseased starved tissue, into which the trunk common to the facial and lingual passed.

In the second case no hæmorrhage or sloughing followed on the ligature of the external carotids. For two months the state of the patient was much improved, the growth showed but little tendency to increase, and the pain and dysphagia did not return. Then profound cancerous cachexia set in, with emaciation and loss of strength, beyond which there is no note.

v. Hæmorrhage from Middle Meningeal Artery after trephining. —This matter has been considered at p. 186, and more fully *Guy's Hosp. Rep.*, vol. xliii., where it is shown that severe hæmorrhage is not uncommon after a wounded middle meningeal has been exposed by trephining, but that the bleeding will usually yield to measures short of ligature of the external carotid.

GUIDE.—The anterior border of the sterno-mastoid above the hyoid bone.

RELATIONS.—The external carotid extends from the upper border of the thyroid cartilage to a point midway between the external auditory meatus and the condyle of the jaw; beyond this point it is continued on as the temporal, having just before given off the internal maxillary. In the first part of its course the external is somewhat nearer the middle line than the internal carotid, and is more superficial than this throughout.

IN FRONT.

Skin; fasciæ; platysma; nerves from transverse cervical and facial; superficial veins.

Lingual and facial veins.

Digastric and stylo-hyoid.

Parotid, facial nerve; temporo-maxillary and other veins.

INSIDE.

Pharynx.

Hyoid bone.

Ramus of jaw.

Parotid.

OUTSIDE.

Parotid.

Temporo-maxillary vein, when this descends to join the internal jugular.

External carotid.

BEHIND.

Parotid gland.

Superior laryngeal.

Glosso-pharyngeal.

Stylo-glossus and stylo-pharyngeus.

The veins in relation with the external carotid vary a good

deal. But, in addition to the lingual and facial crossing it, a number of veins joining the external and anterior to the internal jugular may form a kind of plexus round the artery, and the temporo-maxillary may descend outside the artery to join the internal instead of the external jugular.

BRANCHES : *

ANTERIOR.	POSTERIOR.	ASCENDING.	TERMINAL.
Superior	Auricular.	Ascending.	Temporal.
thyroid.	Occipital.	pharyngeal.	Internal
Lingual.			maxillary.
Facial.			

Operation.—This is performed at two spots :

a. Below the digastric (Figs. 136, 137).

b. Above this muscle, behind the ramus of the jaw.

a. Below the Digastric.—This is the operation more frequently performed in order to cut off the blood-supply through all the branches of the artery. Though these are so numerous, and vary somewhat, there is usually a spot, from $\frac{1}{2}$ to $\frac{3}{4}$ inch, between the superior thyroid and the lingual on which a ligature may be safely placed, especially if the superior thyroid and linguals are ligatured as well.

The position of the patient's head and that of the surgeon being the same as at p. 482, an incision 3 inches long is made, in the line of the artery, from the angle of the jaw to the upper border of the thyroid cartilage, about $\frac{1}{4}$ inch in front of the anterior border of the sterno-mastoid. This incision should divide skin, fasciæ, and platysma; any superficial veins being secured, the cellular tissue in front of the muscle is opened up, and the posterior belly of the digastric or the hypo-glossal sought for as guides to the vessel. In doing this the sterno-mastoid should be drawn outwards, any large veins—*e.g.*, facial or lingual—pulled aside with a strabismus-hook or secured with double chromic-gut ligatures before division. The muscle or the nerve being defined, the pulsation of the artery is felt for below them, and the vessel carefully cleaned just above the thyroid cartilage. The use of the steel director or knife should be most cautious on the outer side of the artery, where lie, below, the internal jugular and internal carotid. At the same time the presence of the descendens cervicis on the artery is to be remembered, and that of the superior laryngeal nerve running obliquely downwards and inwards behind the vessel. The needle should be passed from without. The superior thyroid and lingual should be ligatured at the same time, and the ascending pharyngeal if it can be found.

* While this is a common arrangement, it is by no means the only one. Very frequently one trunk gives off two or three arterics. Sometimes all the branches, save the two terminal, arise very close together, the external carotid constituting then an arterial axis. It is the presence of these branches which enables the surgeon to decide whether he is dealing with the external or internal carotid.

b. Above the Digastric, behind the Ramus of the Jaw.—This operation has the disadvantage of probably entailing the division of important branches of the facial nerve.

The head and shoulders being duly raised and supported, th

FIG. 137.



Ligature of the temporal, facial, external carotid, and occipital artery is shown here. In the ligature of the external carotid, the angle of the jaw, digastric, and the opened deep cervical fascia are seen above. Overlying the artery is an enlarged lymphatic gland; outside it is the inner edge of the sterno-mastoid; the facial vein crosses it, and descending to join this on the inner side is a large communicating branch from the internal maxillary vein. The occipital artery is shown ligatured behind the mastoid process. The edges of the cut posterior half of the sterno-mastoid are shown in the upper and lower parts of the wound. Above the artery, under the upper part of the thread, is a part of the splenius capitis, cut. The vessel itself rests on some fascia continuous with that over the complexus.

surgeon makes an incision downwards from the tragus of the ear, just behind the ramus of the jaw, dividing the skin and fasciæ. The sterno-mastoid must now be drawn outwards and the digastric and stylo-hyoid downwards, and it will probably be needful to divide these latter muscles partially in order to secure the artery

before it enters the parotid gland, this structure being drawn upwards and forwards.

The needle may be passed from either side as is most convenient to the surgeon.

Several veins communicating between the facial and the external jugular will probably cross the line of incision, and must be dealt with.

LIGATURE OF THE INTERNAL CAROTID.

Indications.—These are extremely few.

1. Wounds, usually Stabs.—The following striking case is quoted by Dr. Lidell,* and reflects the greatest credit on the medical men concerned :

On July 31, 1869, a man was wounded in the neck, at the angle of the lower jaw, by a knife, which penetrated several inches, opening the internal carotid. Alarmed by the tremendous outjets of arterial blood, Dr. Denning, in whose drug-store the stabbing occurred, at once compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it. Hæmorrhage now occurring from the upper end was arrested by a ligature on the distal side of the wound. The patient was pulseless, and death was considered imminent, but, under energetic stimulation with whisky and ammonia, the circulation soon became good, and the patient made a good recovery, being in active work nine years later.

2. Aneurism.†—If this is non-traumatic‡ in origin and sacculated, the decision as to treatment, if pressure has failed, must lie between the Hunterian operation of ligaturing the common carotid, or, if the artery is sound, and if there be room above as well as below the aneurism, of placing ligatures above and below the sac, and opening this to turn out the clots. But one or both of the above conditions may very likely be absent.

If the aneurism be traumatic, resulting from a stab or gunshot injury in the neck, or if, in spite of other treatment, it is steadily increasing, the only operation likely to avail is the old one.

The following cases are excellent instances of the difficulties which may be met with in these cases, and how they should be dealt with :

Dr. Prewitt, of St. Louis (*Trans. Amer. Surg. Assoc.*, vol. iv. p. 233), has recorded the following most interesting case of traumatic aneurism : A negress, aged seventeen, was shot with a revolver bullet, which entered the cheek over

* *Intern. Encycl. of Surg.*, vol. iii. p. 111; *Amer. Journ. Med. Sci.*, January 1879, pp. 142, 143.

† Aneurism of the internal carotid here refers to the cervical part of the artery. The treatment of orbital aneurism, which often depends on arterio-venous communication (traumatic or idiopathic) between the internal carotid and the cavernous sinus, has already been considered at p. 477.

‡ The rareness of disease, and thus of idiopathic aneurism, here is well known.

the malar bone and passed backwards. Profuse hæmorrhage took place at once from the wound of entrance, there being none of exit. This was controlled by pressure. A swelling quickly appeared between the ramus of the jaw and the mastoid process, which three months later was found to project into the pharyngeal cavity, crowding the tonsil over the middle line and resting against the uvula.* Externally the swelling reached from the temporal bone to the hyoid. Expansile pulsation, well-marked bruit, and thrill were present. Sense of taste was lost in the right side of the tongue, which was atrophied, and, when protruded, inclined to the right. Pressure on the common carotid arrested pulsation in the tumour, and caused some decrease in size. There was no perceptible difference in the right and left temporal pulses; the pupils were equal. There was persistent headache, and sometimes roaring in the right ear. Difficulty in swallowing had existed from the first. The general condition was unsatisfactory.

It was decided to tie the common carotid at once, but though the pulsation and thrill in the sac seemed arrested at first, they returned in a few minutes. It was then decided, as a forlorn hope (because the diagnosis had placed the opening of the sac close to the carotid foramen), to extend the incision upwards in front of the tragus to determine the feasibility of laying open the sac, and tying the vessel upon the distal side of it.

A cautious dissection† at the back and upper part of the sac showed that this filled all the space between the mastoid process behind and the condyle and ramus of the jaw in front, the sac seeming also to blend with the skull or to be closely adherent to it. A little reflection made it apparent that any attempt to deal with the sac after the method of Mr. Syme would in all probability prove disastrous, as it would almost certainly be found that there was no portion of the artery between the carotid foramen and the sac to be tied. The wound was washed out with bichloride solution, drained and closed. On the evening of the eighth day, there having been pyrexia and free suppuration of the wound in the interval, hæmorrhage took place from the sac. The wound was enlarged, and search made with the finger for the orifice of the artery or the carotid foramen. The search being fruitless, and it seeming certain that laying open of the sac or removal of the finger would be followed by speedily fatal hæmorrhage, the sac was packed with strips of lint rolled in iodoform. Hæmorrhage did not recur, but the patient died exhausted twenty-five days after the first operation.

The autopsy was conducted under great difficulty, but it was thought that it was made out that the opening in the artery was close to the carotid foramen. Death seemed largely due to septic causes—*e.g.*, thrombosis of the inferior petrosal and of the lateral sinuses.

* With reference to this tendency of internal carotid aneurisms to project inwards, Dr. Prewitt thus quotes from Prof. Agnew (*Surgery*, vol. i. p. 591): "The deep situation of the artery, covered as it is externally by the stylo-hyoid, stylo-pharyngeus, and stylo-glossus muscles, and by dense aponeurotic structures which extend down to the styloid process, prevents any very marked prominence of such a tumour on the surface of the neck, and, as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle, its extension inwards becomes an anatomical necessity. Indeed, in this peculiarity lies the chief difference between aneurism of the internal carotid and aneurism situated at the division of the common trunk."

† It was suggested by Prof. Agnew, at the discussion on this paper, that the jaw should have been divided and the pieces pulled aside to facilitate further dissection, but Dr. Prewitt found that the jaw and sac were closely adherent, and, even if separation could have been effected, there would have been no artery above that could have been tied.

Dr. Prewitt points out that such an aneurism might be mistaken for one of the occipital, vertebral, and perhaps of the internal maxillary or one of its branches. The chief diagnostic points are the projection into the pharynx, the evidence of pressure on the vagus and glosso-pharyngeal (p. 500), and the exclusion of the vertebral, by the effects of digital pressure below the sixth cervical vertebra (p. 504). He also shows by several cases that aneurism of the internal carotid has repeatedly, owing to the interference with speech and swallowing, the pain in the neck, and the difficulty in opening the mouth, been taken for tonsillar abscess, and with fatal results. One of these cases may be quoted here :

A man, aged twenty-eight, was shot, on September 30, 1879, through the right infra-orbital region. No hæmorrhage. At the end of a week the swelling in the face had entirely subsided, but tumefaction of the right side of the neck remained. On the eighth day the patient was out. On the fifteenth he called at Dr. Lee's office, and complained of inability to speak or swallow, and also of severe pain in the right side of the neck, which he said he could not bend. His appearance was that of a man suffering from severe tonsillitis. With considerable difficulty Dr. Lee succeeded in opening the patient's mouth enough to permit of limited inspection. The tonsils and soft palate were so swollen as to preclude inspection of the pharynx. On the hard palate there was a small firm tumour about the size of a hickory-nut. Thinking this might be the ball surrounded by inflammatory products, an exploratory incision was made. On the removal of some clots of blood, there was a gush of arterial blood. In consequence of the struggles of the patient, Dr. Lee was unable to control the hæmorrhage, and death ensued in a few minutes.

In the discussion which followed on Dr. Prewitt's paper, the following case of traumatic aneurism of the internal carotid following a stab in the neck was related by Dr. Briggs, of Nashville :

A man, aged twenty-three, had an expansile tumour in the left parotid region, encroaching on the throat, causing difficulty in swallowing. There was a loud bruit, and pulsation in the swelling was lessened by pressure on the common carotid. A small cicatrix pointed to the receipt of a stab six weeks before.

Acting on the principle that a traumatic aneurism is simply a wounded artery, and should be treated as such, Dr. Briggs performed the old operation. A knife being pushed into the most prominent part of the swelling, this opening was plugged with a finger, which appeared to find the wound in the artery. The opening being enlarged upwards and downwards, large clots were removed, followed by a gush of arterial blood, which was arrested by stuffing the wound with sponges. The incision being prolonged downwards, the common carotid was tied. On the removal of the sponges, the hæmorrhage was as violent as before, and was only arrested by the pressure of a finger in the sac. While this was kept up, the tissues were scratched through, and a ligature placed above and below the opening. Though the incision measured 8 inches, there was scarcely sufficient room. At the bottom of the wound the styloid process could be seen, and just anterior and internal to it the ligatures on the internal carotid. The patient made a good recovery.

It will be seen that the two cases of Dr. Prewitt and Dr. Briggs differ widely. Though both were traumatic, in one there

was room to place a distal ligature,* in the other there was not. The fact that, in the latter, hæmorrhage did not recur for the twenty-five days in which the patient lived after plugging the sac, leads one to hope that plugging with aseptic gauze, firmly and carefully against the base of the skull, might be successful in such another case, if the wound could be kept aseptic, and the dysphagia met by tube-feeding.

LINE AND GUIDE.—These are practically the same as those given for the common carotid. The internal carotid lies outside and rather behind the external carotid. Soon after its commencement it becomes too deeply placed to admit of ligature.

RELATIONS IN THE NECK:

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid; stylo-glossus; stylo-pharyngeus.
Glosso-pharyngeal nerve.
Parotid gland.

OUTSIDE.

Internal jugular.
Vagus.

INSIDE.

Pharynx.
Ascending pharyngeal.
Tonsil.

Internal
carotid.

BEHIND.

Rectus capitis anticus major.
Superior laryngeal nerve.

Operation.—This is much the same as that for ligature of the external carotid. The artery can only be tied in its first and more superficial part. It here lies outside and rather behind the external carotid.

Thus the incision should be made along the anterior border of the sterno-mastoid, and not just in front of it, the centre of the incision lying about $\frac{1}{2}$ inch above the upper border of the thyroid cartilage. The sterno-mastoid being defined, and the cellular tissue opened up in front of it, the same superficial structures will be met with as in the external carotid (p. 496). When the carotids are found, the external should be drawn inwards, and the digastric upwards. The needle should be passed from without inwards, avoiding the internal jugular and the vagus.

LIGATURE OF THE VERTEBRAL ARTERY.

Indications.

(1) Wounds, (2) Traumatic Aneurisms, may be considered

* Dr. Briggs, in replying (p. 256), said that, though the opening in the internal carotid was very close to the carotid canal, not more than $\frac{1}{4}$ inch from it, the operation was not so very difficult.

together. There is liable to be much obscurity as to whether it is the vertebral or some other artery—*e.g.*, inferior thyroid, ascending cervical, common carotid, or, if higher up, the occipital—which is attacked, and, when it is decided that it is the vertebral artery, it is by no means easy to carry out satisfactory treatment. The best course is to enlarge the wound, and to decide, with the finger, the relation of the wounded vessel and of the hæmorrhage to the transverse processes of the vertebræ. The direction of the wound, and the effect of pressure below and above the level at which the vertebral ceases to be compressible—*i.e.*, above the "carotid tubercle" (*vide infra*)—will also be helpful.

If the wound is low down, there are between 2 and 3 inches of the artery available for ligature, and this should be placed above and below the wound. But if, as is more frequent, the wound is higher up in the neck, it will be almost impossible, even after exposing and clipping away the anterior roots of the transverse processes, to find and secure the artery, and the best course will be to plug the wound, as successfully done by Dr. Kocher, of Berne.*

A man, aged forty-eight, had been stabbed in the neck. Daily hæmorrhages, often profuse, took place for three weeks, in spite of plugs of charpie soaked in perchloride of iron. On admission into the hospital a wound was found about an inch to the left of the spine, at the level of the fifth and sixth cervical vertebræ. Through the wound was seen a swelling, feebly pulsating. On removing coagula and opening up the wound, free arterial hæmorrhage came from a cavity about the size of a small apple, at the bottom of which transverse processes could be felt. The bleeding came from both the central and peripheral ends of the artery, between the transverse processes of apparently the fifth and sixth vertebræ. As a ligature could not be applied, a pea-like bit of charpie, soaked in solution of iron perchloride, was introduced between the transverse processes. The head was kept fixed with a stiff collar. On removal of the plug on the fourth day, partly with a stream of water, partly with forceps, no bleeding followed. The patient was discharged cured in five weeks, having had a slight attack of erysipelas.

In the above paper Maisonneuve is said to have tied the vertebral and inferior thyroid arteries, and removed a bullet. The hæmorrhage was arrested, but death occurred from purulent infiltration into the spinal canal. The above appears to have been a case of ligature of the artery before its entrance into the vertebral canal.

Aneurisms of the vertebral are always traumatic. There are about twenty-four † cases on record of aneurisms and wounds of this vessel. The situation varies much. Usually it is high up, near the mastoid process. ‡

* Langenbeck's *Arch. f. Klin. Chir.*, Bd. xii. S. 867. A full abstract of the paper is given in the *Syd. Soc. Bien. Retr.*, 1871-72, p. 202.

† Barbieri, of Milan, quoted by Kocher (*loc. supra cit.*), has collected sixteen; Pilz (Langenbeck's *Arch. f. Klin. Chir.*, Bd. ix.) has gathered together four. Then there is Kocher's, one by Lücke in the same *Arch.*, Bd. viii. S. 78, and the American case given below.

‡ In nine, according to Kocher, the wound was at or above the second cervical

The difficulty of diagnosis of wounds of the vertebral and other arteries, and their results, has been already alluded to. Mr. Holmes (*Lancet*, July 26, 1873) states that there are eleven cases in which the carotid has been tied for wound or aneurism of the vertebral, of course with no advantage. This mistake seems to have arisen from forgetfulness of the fact that, while pressure on the common carotid below the transverse process of the sixth cervical vertebra will check all pulsation in the carotid, the branches of the carotid, and aneurisms situated on them, it will also check pulsation in a vertebral aneurism. Mr. Holmes points out that the above "carotid tubercle" is higher up than is usually supposed, being situated 2 to 3 inches above the clavicle, and he lays down the rule that, when a traumatic aneurism is situated in the course of the vertebral, and its pulsations are commanded, however completely, by pressure on the common carotid low in the neck, it ought not to be treated as being carotid, or as affecting a branch of the carotid, until it is clearly proved that its pulsations are stopped by pressure applied above the level at which the vertebral ceases to be compressible—i.e., above Chassaignac's carotid tubercle. Ligature of the vertebral artery in the first few inches of its course being so very rarely available, compression of the artery low down, with the aid of an anæsthetic if needful, and with the additional help of direct pressure or cold on the aneurism above, should be made use of.

Dr. Weir (*New York Archives of Medicine*, 1884) records a case of a man stabbed on the right side of the neck, about $\frac{3}{4}$ inch below the ear, just in front of the sterno-mastoid. A traumatic aneurism, believed to be of the vertebral, slowly developed. Digital pressure over the carotid tubercle was made use of, and in three hours the tumour was cured.

If pressure fails, and if the aneurism increases in size, the surgeon must decide between running the risk of injecting ergotine, or the use of coagulants, or opening the swelling and plugging it. In the latter case aseptic gauze strips—viz., iodoform or sal alembroth—should be made use of in preference to the perchloride of iron. The gauze should be carried into the aneurism, the wound being opened sufficiently freely to allow the surgeon to see what he is about, and the head should afterwards be kept rigidly still.*

(3) Ligature of the Innominate Artery, either at the same time to prevent Secondary Hæmorrhage, or, later on, to arrest this when it has occurred at the seat of Ligature owing to the Reflux of Blood from the Subclavian (p. 534).

vertebra; in two, "at the upper part of the neck;" in six it was below the second cervical vertebra. In four of the latter it was in the neighbourhood of the external carotid artery and its branches; thus in one the wound was at the angle of the jaw.

* In one case related by Kocher the nerves lying behind the artery were injured, and, in another, dangerous inflammation of the spinal meninges took place.

(4) Epilepsy.—Dr. Alexander, of Liverpool, has performed this operation in thirty-six cases, after the first case usually tying both arteries simultaneously. The following (*Dict. of Surg.*, vol. ii. p. 786) is his opinion of the value of the operation :

The operation was performed in the hope that a diminution of blood to the hinder brain and spinal cord would result in a lessening or cessation of the epileptic convulsions, it being expected that the diminution would be more permanent to the parts supplied after ligature of the vertebrals than after ligature of other vessels, on account of the absence of anastomosing branches, and the restraints to dilatation of the unligatured vessels by the long canals through which the vessels pass. For a time these expectations were realised, but soon relapses occurred, and in May 1884 an analysis of thirty-six cases showed only eight cases which have had so few fits since operation that they may be practically considered cured. Eleven were for several months so much improved that they seemed to be cured; and although the fits have recurred in all, yet the improvement is still distinctly manifest in many. In sixteen cases there did not seem to be any decided improvement. Three died out of the thirty-six—one from hæmorrhage, one from embolism, and one from pleurisy. All the cases operated on were chronic, hopeless epileptics, many of whom had become, gradually, mentally affected. Not one of the latter was permanently benefited to any practical extent. On account of the uncertainty as to what cases will derive benefit from the operation, Dr. Alexander has ceased to recommend or perform the operation. As far as he can at present see, this chapter of surgery may be closed.

RELATIONS.—The vertebral artery, the largest and usually the first branch of the subclavian, arises from the upper and back part of the artery, and ascends at first a little outwards and backwards to reach the foramen in the transverse process of the sixth (sometimes the fifth or seventh) cervical vertebra. Traversing these foramina, it passes through that of the axis; it then bends outwards and upwards to reach that of the atlas, and then passing backwards lies in a deep groove on the posterior arch of the atlas behind the articular process, beneath the sub-occipital nerve. In this position it lies in the sub-occipital triangle. Finally, it pierces the posterior occipito-atloid ligament and dura mater, and, running upwards and forwards through the foramen magnum, winds round to the front of the medulla to join its fellow and form the basilar at the lower border of the pons Varolii.

BEHIND.

Cervical nerves (in vertebral canal).

Sympathetic plexus.

OUTSIDE.

Scalenus anticus and phrenic nerve.

Vertebral Artery.

INSIDE.

Longus colli.

IN FRONT.

Internal jugular.

Inferior thyroid.

Thoracic duct (left side) crossing from within outwards.

Vertebral vein (often plexiform).

Sympathetic plexus.

Operation.—The head being suitably raised and turned slightly over to the opposite side, an incision, 3 inches long, is made along the outer border of the sterno-mastoid, extending to the clavicle. In deepening this incision, the external jugular must be looked out for, running parallel, here, with the outer border of the muscle. When the deep fascia is divided, the sterno-mastoid, together with the vein, is to be drawn inwards, the incision being prolonged along the clavicle, and some of the clavicular fibres detached from the bone if needful. The surgeon then, working with the narrow point of a steel director, carefully opens up the deep connective tissue, and endeavours to define the interval between the scalenus anticus and the longus colli muscles; as the outer border of the former muscle corresponds with that of the sterno-mastoid, this muscle must be well retracted inwards. In defining the vertebral artery as it lies between the scalenus and longus colli, the presence of the phrenic nerve lying on the scalene, the pleura internally, the internal jugular, inferior thyroid, and the vertebral veins over the vessel, with the thoracic duct crossing it, on the left side, from within outwards, must all be borne in mind, these structures being drawn to either side, as is convenient, with strabismus hooks. The depth of the wound and venous hæmorrhage are difficulties at this stage. The needle is then passed from without inwards. Owing to the deep position of the artery, a good light is essential, and the head must be manipulated so as to relax the deep parts as is required. The anterior transverse tubercle in the sixth cervical vertebra is a good guide in cases of difficulty; below it, the pulsation of the artery should be felt. In cleaning the artery previous to passing the ligature, the fibres of the sympathetic must be disturbed as little as possible. Temporary paralysis from the interference with these fibres is almost certain, and immediate contraction of the corresponding pupil is of very frequent occurrence, and may be regarded as a pretty certain indication that the vessel has been secured. If the vertebral vein is wounded and cannot be secured separately, ligatures should be placed on artery and vein together, above and below the wound in the latter.

It has been suggested by Dietrich to tie the vertebral artery between the atlas and axis. This operation would prevent the reflux of blood from above after a wound or traumatic aneurism below had been plugged; but however feasible as a dissecting-room operation, it would be one of great difficulty on the living.

owing to the depth and small part of the artery which is to be tied.

LIGATURE OF SUBCLAVIAN.

As it is very doubtful whether ligature of the first part is a justifiable operation even in these days of improvements in aseptic surgery and of new ligatures, the operations on the second and third parts will be described first, the two being taken together, as one operation is often only an extension of the other. The operation on the first part will then be more briefly alluded to (p. 517).

LIGATURE OF SUBCLAVIAN IN ITS SECOND AND THIRD PARTS (Fig. 138).

LINE.—From the curved and short course of this vessel no definite line can be given.

GUIDE.—The chief point to remember is the outer margin of the sterno-mastoid, as this corresponds to the outer border of the scalenus anticus, which has to be defined and then traced down to the tubercle on the first rib, the part of the artery to be tied lying on the upper surface of this bone, outside and behind the muscle and tubercle.

RELATIONS (third part):

IN FRONT.

Skin; fasciæ; platysma; branches of cervical plexus.

Venous plexus—viz., external jugular; supra-scapular; posterior scapular; transverse cervical; branch from cephalic.

Transverse cervical and supra-scapular arteries.

Cellular tissue and fat.

Nerve to subclavius.

Subclavian vein (below).

ABOVE.

Omo-hyoid.

Cords of brachial plexus.

Subclavian
(third part).

BEHIND.

First rib.

RELATIONS (second part):

IN FRONT.

Skin; fasciæ; platysma.

Sterno-mastoid.

Scalenus anticus.

Phrenic nerve.

ABOVE.

Cords of brachial plexus.

Subclavian artery
(second part).

BELOW.

Pleura.

BEHIND.

Scalenus medius.

Collateral Circulation.

When a Ligature is applied to the Third or Second Part.—Three main sets of vessels * are here employed—viz.,

ABOVE.

The supra-scapular,
The posterior scapular,
The superior intercostal,
The aortic intercostals,
The internal mammary,
Numerous plexiform vessels
passing through the ax-
illa from branches of the
subclavian,

with

with

with

BELOW.

The acromio-thoracic, the
infra-scapular, sub-scapu-
lar, and dorsalis scapulae.

The long thoracic, and sca-
pular arteries.

Branches of the axillary.

When a Ligature is applied to the First Part.—The collateral circulation may be carried on by the superior anastomosing with the inferior thyroid, one vertebral with its fellow, the internal mammary and superior intercostal with the long thoracic and scapular arteries, and the princeps cervicis with the profunda cervicis (Smith and Walsham, p. 38).

Indications.

i. In some cases of axillary aneurism—*i.e.*, those in which, owing to the pain, the irritability of the patient, the depth of the artery, the rapid increase of the aneurism—pressure is not available.† With regard to the operation of ligature of the subclavian for axillary aneurism, it should be remembered that the mortality has been high. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 109) thus explains this fact: In the first place the procedure resembles Anel's operation almost as much as Hunter's. Hence, suppuration of the sac from loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature must be placed in the immediate vicinity of large branches. Then, again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurismal sac, and by the want of resistance in the parts which surround it. Sir J. E. Erichsen (*Surgery*, vol. ii. p. 212) also alludes to the unfavourable results after ligature of the subclavian for axillary aneurism—*i.e.*, out of forty-eight cases, twenty-three were cured and twenty-five died; and attributes the high mortality chiefly to three causes—viz., (1) inflammatory changes within the chest; (2) suppuration of the sac; (3) hæmorrhage.

* Key, *Guy's Hosp. Reports*, 1836. A case in which the subclavian artery had been tied for axillary aneurism twelve years previously.

† See the conclusions on axillary aneurism formulated by Mr. Holmes in his "Lectures at the College of Surgeons," p. 107.

See below, p. 512, where the chief points in the after-treatment are given.

ii. Cases of subclavian and subclavio-axillary aneurism not amenable to other treatment; or where the aneurism, especially if subclavio-axillary, is small in size (not larger than a hen's egg), of recent duration, and distinctly traumatic in origin. Mr. Poland (*Guy's Hosp. Reports*, 1871) in his report on subclavian aneurism, gives nine cases of recovery and twelve cases ending fatally after ligature of the second or third portions of the subclavian for subclavian or subclavio-axillary aneurism. With regard to the nine successful cases Mr. Poland raises a very important question. Was the aneurism developed in a healthy artery? If so, the success is explained. In three the aneurism was entirely local, independent of general arterial disease. In two this was doubtful. In four the origin was spontaneous. Whether general atheroma existed here must remain uncertain, as the patients recovered, and the artery, where tied, was healthy. "We can only say this, that subclavian aneurism in its early stage, occurring in persons of the early or middle period of life, without any indication of disease of the heart or large vessels, may and does recover, and that a cure may be effected by means of a ligature of the third or second portion of the artery notwithstanding the disease is one of spontaneous origin, and therefore presumed to be indicative of arterial disease." In these successful cases the size of the aneurism in no case exceeded that of a hen's egg, and the duration of the cases was short, being under four-and-a-half months.

Of the twelve unsuccessful cases of subclavio-axillary aneurism there was good reason to believe that in ten at least an atheromatous condition of the arteries existed. The size of the aneurism was, in all save one, larger than in the first group.

iii. As a distal operation, together with ligature of the common carotid for some cases of aneurism of the innominate and aorta. See p. 538.

iv. Preparatory to such operations as interscapulo-thoracic amputation (p. 154).

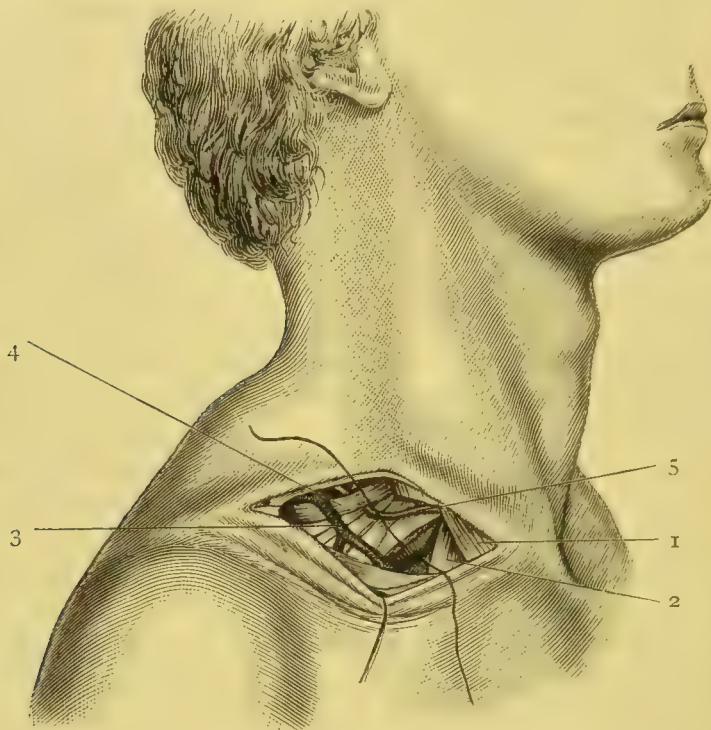
v. For wounds of the subclavian itself—*e.g.*, stabs. This is very rarely called for.

Operation for Ligature of the Third or Second Portion of the Subclavian (Fig. 138).—These two will be considered together, as one operation is but an extension of the other.

The patient being turned over on to the sound side, propped up with pillows at the edge of the table, the head drawn over to the opposite side, the shoulder on the side of the aneurism is depressed as strongly as possible, so as to open out the posterior triangle. The surgeon then, standing in front of the shoulder, draws the skin down over the clavicle with his left hand, and makes an incision, 3 inches long, over this bone, between the sterno-mastoid and trapezius, dividing skin, fasciæ, and platysma.

The soft parts being now allowed to glide up, the incision should lie $\frac{1}{2}$ inch above the clavicle, the external jugular vein thus escaping injury, for as this vein perforates the deep fascia just above the clavicle, it cannot be drawn down with the skin, superficial fascia, and platysma. If more room is required, owing to the elevation of the clavicle or the presence of an aneurism, the above muscles must be divided, and a longitudinal incision made upwards,

FIG. 138.



Parts concerned in ligature of the third part of the subclavian. 1. Sterno-mastoid. 2. Scalenus anticus, below which the subclavian artery is seen deeply, with a ligature passed below it. 3. External jugular vein joining the venous plexus here met with. 4. Omo-hyoid. 5. Transversalis colli artery.

at right angles to the inner end of the first, and a triangular flap raised outwards and upwards.

When the superficial parts have been sufficiently incised, the deep fascia is carefully opened at the inner end of the incision and laid open on a director, and the areolar tissue beneath, which varies much in density and the amount of fat which it contains, scratched through in a direction aiming for the outer edge of the scalenus anticus, which corresponds to the outer margin of the clavicular part of the sterno-mastoid. As soon as the deep fascia is divided, the presence of the following complications must be remembered and provided for. The soft tissues may be much matted, œdematous, and altered owing to previous use of pressure or inflammation set up around a rapidly growing aneurism. The venous plexus formed by the external jugular receiving the supra-

scapular and transverse cervical veins, and, often, the posterior scapular and a branch over the clavicle from the cephalic as well, may be much engorged. Any one or more of these veins which are in the way should be drawn aside with a strabismus hook or aneurism needle, or divided between two chromic catgut ligatures. (Owing to the free anastomoses, this latter course is to be adopted without hesitation if needful. It cannot be insisted upon too strongly that a bloodless wound will best enable the surgeon to reach this often most difficult artery, and a bloodless wound is best secured by tying beforehand every vein which cannot be drawn out of the way, and by using a fine-pointed steel director as much as possible after the deep fascia is opened.)

As a rule, the transverse cervical artery is above the incision, and the supra-scapular below it, under the clavicle, but occasionally one or both of these may be found lying across the field of operation, and must then be drawn aside with a strabismus hook. While the veins may be ligatured without hesitation, the arteries must be preserved intact, that the collateral circulation may not be interfered with (p. 508).

The omo-hyoid varies in position, and may be neglected.

The outer edge of the scalenus anticus being defined by scratching through the cellular tissue, this muscle is to be traced downwards to the scalene tubercle on the first rib, immediately above and behind which landmark lies the artery. One of the lowest cords of the brachial plexus will now come into view, and is another good guide to the artery.

George A. Wright, of Manchester ("Case of Ligature of Subclavian Artery for Axillary Aneurism," *Ann. of Surg.*, 1888, p. 362) emphasises the value of the lowest nerve cord as a guide in preference to the scalenus anticus and the scalene tubercle. In his case the muscle was not a very good guide, as "the tense fascia reaching from its posterior border to the sheath of the artery obscured the line of the muscle," and as the artery rose fairly high in the neck the tubercle was not of much value either.

This cord must not be mistaken for the artery, a contingency otherwise not unlikely to happen, as the lowest cord is in close contact with the artery and may receive pulsation from it.* A little cleaning will show the fasciculation of the nerve, where the artery is closer to the rib, and is flat, not rounded, when rolled under the finger.† By compressing the artery between the needle passed

* Mistaking a cord for the artery, or tying the two together, has happened to excellent surgeons. Thus, in a case under the care of Mr. Green, of St. Thomas's Hospital, one of the cords was included in the ligature. The agony produced was extreme; the man did not cry out, but the expression of his face was something most appalling. The ligature was immediately loosed, and the artery alone tied, and all the frightful symptoms disappeared. The man made a good recovery, and was seen many years afterwards perfectly well (Poland, *loc. supra cit.*, p. 83).

† Another difficulty about the pulsation is its variableness. Sometimes it is violent and excited; at others, as in the case of a dilated and diseased artery, or one much handled in the operation, almost imperceptible.

beneath it and his forefinger, and noting the result of this pressure on the aneurism and the pulse below, the surgeon will clear up any doubts as to whether he has the artery or no.

The position of the artery being made sure of, the sheath* is opened with the point of the knife, the artery cleaned, and the needle passed from above downwards and from behind forwards. This best avoids the worst risk—*i.e.*, of including a nerve cord. The needle should be kept most carefully close to the vessel, and not dipped suddenly or used with any force; otherwise the pleura or subclavian vein may be injured.†

The artery, before the ligature is tightened, will be inspected with some anxiety as to its condition—whether normal in size and structure, or dilated, thickened or thinned.‡ If much alteration is found, the surgeon should carefully divide the outer half of the scalenus anticus on a director with a blunt-pointed bistoury, sponging the wound absolutely dry so as to watch for the phrenic nerve, which, if seen, should be drawn inwards with a strabismus hook.

If the artery is found diseased here also, the surgeon should use a flat ligature of ox-aorta or kangaroo-tail tendon, and endeavour so to adjust the tightening of the ligature as not to divide both the internal and middle coats (pp. 521, 523).

In cases where the wound is a very deep one, care must be taken while making the second knot that the first does not slip. The ligature having been tightened and cut short, drainage is provided and the wound carefully closed and dressed. The limb is then bandaged with cotton-wool and kept somewhat supported, and the temperature maintained with hot bottles if needful.

The Chief Points in the After-treatment are—(i) keeping the wound rigidly aseptic, (ii) arresting hæmorrhage, (iii) meeting suppuration of the sac, (iv) combating the stiffness and weakness of the limb which sometimes follow on ligature of the main trunk.

(i) This need not be further alluded to in a work like this, but it cannot be too strongly insisted upon that, if the high mortality (pp. 508, 509) which has hitherto attended this operation is to be

* A process of deep cervical fascia which the vessel brings out from between the scaleni, and one which varies much in density.

† The surgeon should be provided with needles of different curves and a silver probe with a large eye. As pointed out by Sir W. Fergusson (*Surgery*, p. 607) with his attention to details in operations, the eye of the needle should always be close to the point, that the ligature may be at once seized with forceps as soon as it appears under the vessel, the difficulties at this stage of the operation being not only the surrounding parts of importance, but also the fact that in this case the handle cannot be depressed as freely as in operations on most other arteries, and thus it is difficult to make the point rise above the vessel.

‡ In a case of Liston's the vessel was dilated, thick, and soft, "aptly enough compared to the finger of a buckskin glove." The patient, aged forty-three, died of hæmorrhage on the fourteenth day. In a patient of M. Jobert's (Poland, *loc. supra cit.*, p. 110) "the vessel was found enormously large, equal to the size of an aorta; pulsation being very marked."

reduced, it is mainly to keeping the wound aseptic throughout, and thus to early primary union, that we must look.

(ii) The risk of hæmorrhage is so great that the surgeon should always endeavour to prevent it by trying to obtain early and firm closure of the wound as just indicated, and by keeping the patient absolutely quiet till all is soundly healed. When once hæmorrhage occurs, the outlook is very grave. The treatment must vary according to the size of the wound which remains. If there be only a sinus, firm pressure must be made over the dressings by well-adjusted bandaging, aided by a heavy bag of shot or a truss-like instrument adjusted for the purpose.*

If the wound is larger, and perhaps septic and sloughy, an anæsthetic should be given, and, any clots being removed, the wound should be gently swabbed out with a solution of zinc-chloride (gr. 20 or 40 to water ℥i), or with iodoform and ether, the wound then dried, dusted with iodoform, and pressure applied as above; or the wound may be plugged with strips of aseptic gauze, the part placed within the wound having being wrung out of turpentine, or with sponges of appropriate size and texture which have been kept in a solution of carbolic acid (1 in 20), and are now wrung dry and dusted with iodoform, silk being attached to the deeper ones before they are inserted. The patient should be kept as quiet as possible with morphia; the diet should be restricted and given at regular intervals, and without stimulants unless absolutely required. The cases collected by Mr. Poland (*loc. supra cit.*, pp. 116, 117) show that while hæmorrhage may occur as early as the eighth day, it may be deferred till the twenty-sixth or forty-sixth day, the ligature having come away on the twentieth day in either case. In neither of these two latter cases had the wound healed: in the first, the patient had been allowed to get up; in the second, pyæmia was present.

The same writer (*loc. supra cit.*, p. 125) thus sums up the sources of hæmorrhage:

(a) *From the sac*, either *primary* from puncture in the operation, or *secondary* from ulceration or rupture at an early period, or later after inflammation and suppuration and giving way of the sac.

(b) *From the ligatured part*, in consequence of non-obliteration of the artery when the ligature is becoming detached, the hæmorrhage being generally from the peripheral end of the artery tied. It may be due also to an unsound state of the coats of the artery, such as dilated, thinned coats or atheromatous degeneration.

It is worth remembering that this hæmorrhage is, in exceptional cases, recovered from.

Mr. Poland (*loc. supra cit.*, p. 127) quotes four cases from the collection of Kocher which recovered after the use of styptics, pressure, and cold, and adds one under the care of Sir W. Fergusson (*Edin. Med. and Surg. Journ.*, 1831,

* In a large hospital, where relays of assistants are available, digital pressure may be made use of.

p. 309), in which the hæmorrhage was arrested promptly and for good by pressure applied immediately by the patient's wife.

(iii) Suppuration of the sac. The frequency of this untoward accident has been already alluded to (p. 508). It is due to the close proximity of the ligature to the sac, without any intervening branch, whereby the necessary coagulum is but ill-formed and loose, acting as a foreign body, and liable to set up irritation, inflammation, and its consequences.

Every endeavour should be made to prevent its occurrence by forbidding all handling of the aneurism.

If evidence of it occur, and the swelling, which has at first diminished in size, again about the second or third week steadily increasing in size, becomes tense and painful, but without pulsation, it must be opened by a sufficiently free incision, carefully emptied of pus and clots, drained, and well-adjusted pressure applied. If the wound has not healed, and particularly if it has become septic, hæmorrhage is extremely likely to occur after opening the sac—an ominous complication, which can only be met by plugging with aseptic sponge or gauze, and using firm pressure (p. 513).

(iv) Atrophy, stiffness, and weakness of the limb. These must be met by warmth, use of electricity, and, above all, by perseveringly used massage.

The condition which is so common in the lower extremity after an analogous operation (see Ligature of External Iliac), in which the limb long remains in a state not far removed from gangrene, is much less common in the upper extremity.

Difficulties and Accidents which may be met with, and Points to avoid, during the Operation.

1. Sterno-mastoid and trapezius almost meeting.
2. A short full neck with much fat both above and beneath the deep fascia.
3. Clavicle much pushed up. This may be due to the patient having carried his shoulder raised to relieve the painful pressure on the nerves, or to the presence of an aneurism.
4. The artery may be displaced.

This deviation from its usual course may be acquired, as in a case of Warren (Poland, *loc. supra cit.*, p. 77), where the left subclavian was raised and displaced by a curvature of the spine in a woman aged thirty, the subject of an aneurism (attributed to strain), about the size of a pigeon's egg, just above the scapula end of the clavicle. Ligature was performed by an incision made obliquely from the outer edge of the sterno-mastoid towards the acromio-clavicular joint, the pulsation of the artery being the guide.

Congenital deviations which have been met with are the artery perforating the scalenus anticus, or lying in front of it or, as usual, behind this muscle, but not closely accompanied by its vein.

5. The soft parts infiltrated, oedematous, or matted together owing to the presence and irritation of an aneurism, aided, perhaps by previous attempts at cure by pressure.

6. Great engorgement of the veins met with here, due to the presence of an aneurism, and increased by the anæsthetic.

7. Aneurismal sac very prominent and liable to be punctured in the operation.

This accident took place in the hands of the elder Travers. The sac was as large as a swan's egg, and pulsated strongly. The patient died on the third day after the operation with effusion into the right pleura. The ligature was firmly seated on the artery at the root of the sac and adjoining the outer edge of the scalenus. The sac had a pouch-like enlargement upwards, which closely overlaid the artery on the pectoral side; and this, having been penetrated in the passage of the needle, had occasioned the profuse arterial hæmorrhage without saltus, which was not arrested by the tightening of the ligature, and which was only controlled by introducing a sponge tent into the wound. The same accident is stated by Sir J. E. Erichsen to have happened to Cusack while ligaturing the subclavian for a diffused aneurism of the axillary artery.

The alarming gush of blood which took place was arrested by plugging the wound, but the hæmorrhage recurred fatally on the tenth day.

8. Wound of the supra-scapular artery necessitating ligature of this branch. As a rule this artery lies too low down to be injured—a complication to be extremely deprecated, as it is one of the chief channels by which the collateral circulation is established (p. 508). In about one out of every three cases the posterior scapular will be found to arise from the third part of the subclavian as a separate branch. Erichsen (*Surgery*, vol. ii. p. 208) advises, if this condition be met with, that the ligature be applied, as far as possible, “to the proximal side of the branch. If necessity obliges the ligature to be applied close to the branch, it is perhaps safer to tie this also, as the anastomosis of vessels in this region is so abundant that the risk of gangrene from the obliteration of a single branch would be very small.” But, according to the post-mortem examination of a case in which Mr. Key had tied the artery twelve years previously for axillary aneurism, the posterior as well as the supra-scapular are very important channels by which the blood is carried into the axillary through the infra-scapular (*Guy's Hosp. Reports*, 1836).

Any artery crossing the subclavian should be, normally, the transverse cervical. This or any other vessel which may be an artery should be drawn aside with a strabismus hook.

9. Pulsation in the artery, weak or deficient, or, on the other hand, excited and tumultuous (p. 511).

10. Including a cord of the brachial plexus (p. 511).

11. Injuring the pleura. This has happened on several occasions during the passage of the needle round the artery, owing to the close proximity of the serous membrane to the vessel, and the difficulty in passing the needle, especially when the clavicle is much raised, rendering it impossible to pass the needle from below, and thus away from, the pleura.

Erichsen (*loc. supra cit.*, vol. ii. p. 212) considers inflammation of the contents of the thorax to be the most frequent cause of death, proving fatal in 1 out of every 2·5 cases. This is not pyæmic, but arises from causes essentially connected either with the operation or with the aneurism itself. “These are referable

to three heads. (a) Septic inflammation of the deep areolar tissue at the root of the neck may extend to the anterior mediastinum, the pleura, and pericardium. . . . (b) The sac may by its pressure inwards, encroach upon, and give rise to inflammation of, that portion of the pleura which corresponds to its posterior aspect.

This occurred in a case in which Mayo, of Winchester, operated and is more liable to happen if suppuration has taken place in the sac; when this occurs, adhesion may take place between this and the pleura, or even the tissue of the adjacent lung, and the contents of the suppurating tumour may be discharged into the pleura cavity or air tubes, and so coughed up. Of this curious mode of termination there are at least two cases on record—one by Bullen in which the patient recovered; the other by Gross, in which the patient died from the escape of the contents of the sac into the cavity of the pleura.

(c) Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the lungs, and although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurism, yet it undoubtedly has occurred as I have myself witnessed in one case."

12. Injuring the nerve to the subclavius or including it in the ligature. This nerve, derived from the junction of the fifth and sixth cervical, usually gives a filament to the phrenic. If, as occasionally happens, this filament is replaced by a nerve constituting an important part of the origin of the phrenic, injury to it will be followed by urgent and speedily fatal dyspnoea.

13. Injury to the subclavian vein. This is rare, as the vein lies below and well away from the artery. But if ligature was called for in a case in which the vein accompanied the artery between the scaleni, this deviation would prove embarrassing.

I have spoken at p. 512 of division of the scalenus anticus if the surgeon does not find the part of the artery beyond this muscle healthy. It is not needful to speak at length and separately of this step, as it is a mere extension of the operation for ligature of the third part, the muscle being also only divided in part. Mr. Poland (*loc. supra cit.*, p. 128) points out that of eight cases in which the scalenus was partially divided, five recovered, and that of these five recoveries the operation was on the left side. These cases thus fully prove that a ligature may be placed on the second part of the artery without fear of want of thrombus formation or of injury to important parts.*

* As shown by Mr. Poland, the remarks of Porter on the numerous and great perils of this operation are scarcely borne out—viz., the phrenic on the scalenus anticus; the thoracic duct lying, on the left side, at the inner edge of the muscle; the three large branches usually given off by the subclavian while between the scaleni; and the close proximity of the first dorsal nerve behind the artery.

LIGATURE OF THE FIRST PART OF THE SUBCLAVIAN.*

As this operation has been performed by surgeons of the highest eminence, and as it affords good practice on the dead subject, it will be given here. It seems most doubtful, however, whether the improvements of modern surgery aided by recently introduced ligatures will ever render this a successful operation, failing as these advantages almost certainly will to meet that secondary hæmorrhage which has proved so fatal from the distal side of the ligature, owing to the facility with which the numerous collaterals bring in blood to this spot.

Sir J. E. Erichsen, who gives what he calls an "appalling" table of fourteen cases, all fatal, condemns the operation as "bad in principle" and "most unfortunate in practice," and considers that it should "be banished from surgical practice."

RELATIONS.—These, owing to the greater depth of the artery on the left side, must be given separately.

IN FRONT.

Skin; fasciæ.

Sterno-mastoid; sterno-hyoid; sterno-thyroid.

Internal jugular and (often) vertebral vein.

Vagus; phrenic; cardiac nerves.

Right subclavian (first part).

BEHIND.

Recurrent laryngeal; sympathetic.

Longus colli; pleura (and beneath).

IN FRONT.

Sterno-mastoid; sterno-hyoid; sterno-thyroid.

Pleura; lung.

Vagus; phrenic; cardiac nerves.

Internal jugular; innominate veins.

Common carotid.

OUTSIDE.

Pleura.

INSIDE.

Trachea.

Esophagus; thoracic duct.

Left subclavian
(first part).

BEHIND.

Sympathetic.

Esophagus; thoracic duct.

Longus colli.

* These remarks refer to the right subclavian. A ligature has certainly once been placed on the first part of the vessel on the left side, Dr. Rodgers, of New York, being the operator, and losing his patient from hæmorrhage on the fourth day. Sir J. E. Erichsen (*loc. supra cit.*) states that Sir A. Cooper failed in an attempt to secure the vessel, and that he is said to have wounded the thoracic duct. See also Mr. Banks' remarks, p. 531.

Operation.—This resembles ligature of the innominate. The following account is taken from Mr. Barwell :*

A triangular flap having been turned upwards and outwards, and both heads of the sterno-mastoid divided, the anterior and, if needful, the external jugular veins are secured with double chromic-gut ligatures, and cut. The fascia over the sterno-hyoid being exposed, "the director, after a little opening in the aponeurosis has been made, can be insinuated behind that muscle, which also must be severed. It is well now to look and feel for the carotid artery before going on to divide the sterno-thyroid, whose outer edge covers that vessel, and never, as far as my experience of the dead subject goes, conceals the subclavian."† The finger of the operator, after division of the sterno-hyoid, readily detects the longitudinal course and pulsation of the carotid, and may with ease push the edge of the sterno-thyroid from off its sheath inward, in which position the muscle should be held with a blunt hook. When thus the sheath of the vessel is brought into view, the operator should look for the large veins that always, but more especially if there have been dyspnoea, overlie it. Choosing a vacant spot, he merely nicks the loose structure in which they lie, and then pushes them up and down, tearing the cellular tissue a little, till the dense fibrous sheath is bared sufficiently—first, to have a small opening made in it, and then to be slit up. This should be done on the front and inner aspect. Now, at this part, the vein diverges a little from the artery, so as to leave a triangular interval, through which the vagus runs. A blunt hook is placed over this, and it is to be drawn with the jugular vein gently outward. The next point is to find the subclavian. To do this the operator must remember that the usual description and delineation of the innominate bifurcation is incorrect. It is generally depicted as if the two branches rose side by side and almost at right angles to each other. In reality, the subclavian springs behind the carotid, and the angle between the two vessels is very acute. Therefore, to detect the subclavian, the operator must place his finger at the back and outer part of the carotid, when, passing it down, he comes, generally a few lines above the clavicle, to the slightly divergent pulsating line of the subclavian, which lies deeper than the carotid by the whole diameter of that vessel.

In selecting the spot for placing the ligature, it is well not to put it quite close to the bifurcation, but also not too near the scaleni, lest the recurrent laryngeal or the phrenic should be injured. The vagus and the jugular vein should be kept, not too forcibly, out-

* *Intern. Encycl. Surg.*, vol. iii. p. 513.

† "The mere division of the muscle is in itself unimportant, but there lies behind it a plexus of large veins, passing from the thyroid body to the internal jugular, generally distended by the dyspnoea accompanying aneurism at the root of the neck. Their division causes profuse bleeding and subsequent difficulty in recognising the deeper parts."

wards, and the needle should be passed from below, while with his left forefinger the surgeon gently presses the pleura downward and outward. Some obstruction behind the artery will very likely be encountered, but it is better gently and patiently to overcome this, and never on any account to attempt to pass the needle the other way; for if this be attempted, the instrument is certain to penetrate the pleura. Having now passed and tied the ligature, the surgeon should consider the advisability of also securing the vertebral. It lies in the groove between the longus colli and scalenus, so that the jugular vein must now be held inwards; the dissection already made will have so nearly exposed the artery that a few touches with a director will lay it sufficiently bare to allow the passage of the needle. The position of the phrenic nerve on the anterior scalene, outside and a good deal in front of the vessel, guards it against much risk of injury, but still it must be carefully avoided. The operator must not mistake the inferior thyroid (which is, however, much smaller, and usually at this part external) for the vertebral* itself.

LIGATURE OF THE INNOMINATE.

There have certainly been over twenty cases, and in only about five have the patients survived.

One of these is the well-known case of Dr. Smyth, of New Orleans (*Syd. Soc. Bien. Retr.*, 1865-6, p. 346), which occurred before the days of antiseptic surgery. The second, under the care of Mr. Mitchell Banks, has never been published. I am enabled, through his courtesy, to give this case below, p. 530. A third successful case of ligature of the innominate has been published by Dr. Lewtas, of the Indian Medical Service (*Brit. Med. Journ.*, 1889, vol. ii. p. 312). While this case, most creditable to the operator, shows what skill and coolness can effect in a terrible emergency, and while it proves that a catgut ligature in a healthy innominate will withstand the force of the blood coming *a tergo*, it must be remembered that the subclavian aneurism here was a traumatic one, and the patient only twenty.

A month before his admission a piece of the breech of a bursting gun had lodged above the right clavicle. A swelling, about the size of a foetal head, occupied the lower part of the posterior triangle, hard to the touch and not pulsating. From a partially healed wound brownish blood had been oozing for three days. As the man was anxious for removal of the foreign body, and as the case seemed to be one of deep cervical suppuration, the opening was enlarged sufficiently to admit the little finger, and a fragment of steel, weighing 3 drachms, removed with dressing-forceps. This was followed by an alarming rush of blood, so profuse as to render impossible discovery of the bleeding point. Fortunately the finger detected the opening in the subclavian behind the scalene, and by pressure an assistant thus arrested the hæmorrhage. The man's condition being desperate, it was decided to tie the innominate and carotid. This was done by

* "In certain cases the aneurismal sac overlying the vertebral artery renders it inaccessible."

an incision along the inner border of the sterno-mastoid and notching the sterno-hyoid and sterno-thyroid. The two vessels were secured with catgut ligatures. A drainage-tube was inserted into the extensive cavity of the original wound, some of the coagula which filled this being removed. The patient made a good recovery.

Mr. Coppinger (*Trans. Royal Acad. Med., Ireland*, vol. xi. 1893, p. 243) briefly mentions a case in which he successfully tied the innominate for a large subclavian aneurism. The variety of ligature used is not stated.

Another brilliantly successful case, and one most encouraging to the surgeon, was under the care of Mr. C. J. Symonds. It has not yet been published, and I am indebted to my colleague for the following notes of the case.

G. McCann, aged fifty-three, was admitted October 1894 for a sub-clavio-axillary aneurism. The most prominent part of the sac was just below the clavicle. The whole of the supra-clavicular space was filled, and the pulsating swelling extended backwards under the trapezius to the scapula. It was just possible to limit the swelling at the border of the sterno-mastoid. Fearing that the artery would be unhealthy in its second part, it was decided to attempt to ligature the first part of the subclavian, and if this proved difficult, or impossible, to secure the innominate. On November 5 a vertical incision was made between the two heads of the sterno-mastoid muscle, and without much trouble the first part of the subclavian was identified. On attempting to pass the needle, a short sharp gush of blood occurred, which stopped on withdrawing the needle. A further dissection of the artery was made, but again, on passing the needle, the hæmorrhage was repeated with greater force. Pressure of the finger stopped it at once, and, though the pressure was removed, the hæmorrhage was not repeated. As apparently some large branch of the thyroid axis was injured, it was decided to ligature the innominate. The sternal head of the sterno-mastoid was, therefore, divided, and an incision made in the median line. Thus, there were two vertical incisions joined by a transverse one along the inner third of the clavicle. The sterno-hyoid and thyroïd were divided, and subsequently sutured with catgut. The common carotid was easily reached, surrounded with a silk ligature. Slight traction was made upon this: the beginning of the sub-clavian was identified and then the innominate brought into view. This was secured by a silk ligature and the wound closed. The muscles were sutured with chromic catgut. The ligature was of stout floss-silk. After a few days two openings appeared, one over the inner end of the clavicle and one in the first vertical incision. Through both of these several pieces of catgut came away, and one piece of silk. The man made otherwise an uninterrupted recovery. The pain rapidly disappeared, the aneurism became quite hard. When seen in June 1895 the usefulness of the hand and arm were gradually returning; the aneurismal sac was hard, but still obvious. There was no pulsation in the brachial or radial. Pulsation could be felt in the carotid above the ligature.

The extreme danger of the operation is due partly to difficulties which may be met with at the time of its performance—difficulties which have driven most skilful surgeons to abandon the operation—but chiefly to the frequency of secondary hæmorrhage.

In an operation which must be performed at such long intervals it will be some time yet before we know how far modern anti-septic surgery is able to diminish the above mortality, with the absence or diminution of suppuration, the more rapid healing, the firmer thrombosis, and the improved ligatures. Sir J. Lister.

speaking of antiseptic ligatures in 1869, wrote thus sanguinely: "For my own part, I should now without hesitation undertake ligature of the innominate, believing that it would prove a very safe procedure."

Two cases have recently been fully reported—viz., Mr. Thomson's and Mr. Bennet May's. In spite of all the care taken, and the use of modern ligatures, neither case ended successfully. Mr. Thomson's case died on the forty-second day, of hæmorrhage, which began on the thirtieth day. It was believed that the sinus which resulted from the drainage-tube became septic, and that the pus had ulcerated into the innominate at a point quite unconnected with the ligature, the latter, ox-aorta furnished by Mr. Barwell, having disappeared. Mr. May's case died of secondary hæmorrhage on the nineteenth day, caused by the large and very hard knot, which had been tied in the ligature used, ulcerating into the vessel (p. 522).

Two more cases, given in detail below, must be added to the above: Mr. Banks' case, dying of hæmorrhage on the thirty-seventh day after ligature of the first part of the subclavian, subsequent to ligature of the innominate (p. 530), and my own, fatal on the tenth day from exhaustion brought on by incessant restlessness (p. 532).

The question which *ligature* is best suited to a large trunk like this, very likely diseased, with blood possibly impelled into it by the closely adjacent heart, and with collateral circulation certain to be quickly set up along the carotid and vertebral, has been much discussed, but Mr. Symonds' successful ligature of this vessel with silk has gone far to help us on this point. And not only this question, but others which arise with it are still awaiting answer, viz., *the tightness with which the ligature should be tied, and the advisability of using a drainage-tube*. With regard to the former, numerous cases, especially those of Mr. Barwell, have proved that, if ox-aorta or kangaroo-tail be properly prepared, their contact with the soft tissues they surround will be unirritating, and that, infiltrated by wandering cells, they will be gradually absorbed, new rings of fibrous tissue forming in their place. Mr. Barwell's cases of ligature of the carotid and subclavian for innominate aneurism have also established these points—(a) that ox-aorta may be so tied as not to divide the inner coat;* (β) that this ligature may produce as permanent and complete obliteration as any silk ligature. Mr. Banks' case (p. 530) also encourages the further use of these ligatures, as kangaroo-tail tendon was used in this, the first case in which a patient has recovered without hæmorrhage after ligature of the innominate for non-traumatic aneurism. I am of opinion that the above cases fairly prove that these ligatures, if properly prepared and tied with sufficient tightness, are free from any tendency to slip prematurely or lose their hold from the knot becoming soft or untied, an objection which could fairly be brought against the catgut ligatures when first re-introduced some years ago. I do not think that another objection brought against them

* It is right to point out that another case of the same surgeon proves that, in attempting not to divide the inner coat, the surgeon may fail to close the vessel at all.

by Mr. Holmes is a valid one. "Mr. Barwell's ligature is, no doubt, flat when laid on a table, but when tied it is hard to see how its sharp edges can be prevented from impinging on the vessel, and if they do they will probably cut the middle coat." With all due respect to such an authority, and speaking only from an experience of two vessels, the innominate and the carotid (p. 532), I think the extreme suppleness which half an hour's soaking in a tepid solution of hyd. perchlor. or carbolic acid brings about in these ligatures removes any risk of "sharp edges." When tying such a vessel as the innominate the surgeon must have several ligatures reliably sterilised, as their breaking is still an accident to be prepared for.

Thus in Mr. May's case the needle—an old-fashioned silver one, flexible, well rounded at the point, and with a large eye—having been passed satisfactorily round the vessel, "was threaded with a small cord, to which a strip of ox-aorta material, kindly sent me by Mr. Barwell, was attached, and by it pulled through. In tightening the tape, I had to draw the ends with very considerable force to stop the pulsation, the vessel offering great resistance and pulsating with great force. Just at the critical moment, however, the material gave way and broke across, and a second piece introduced in a similar manner suffered the same fate. I then endeavoured to imitate the principle of the flat ligature by using a cord made up of five or six medium-sized threads of catgut. This bore the strain very well, and, after tightening with sufficient force to completely stop pulsation in the tumour and branches of the carotid, I drew on the ends still further to allow of some subsequent relaxation in fixing the knot. At the same time I endeavoured to avoid crushing the coats of the artery. The ligature was secured with a third knot, and cut short." The patient died of hæmorrhage on the seventeenth day, and it was found that this very precaution, taken with all care and thoughtfulness by Mr. May, had tended to bring about the fatal result. "The ligature still retained a firm hold on the vessel; one or two of the threads were partially absorbed and softened, but others scarcely changed. The knot, unfortunately very large and hard, was quite unaltered. Under the knot, in the front of the vessel and in the line of a fold or bend of its wall was the obvious source of the hæmorrhage, in the form of a ragged hole about the size of a small pea; this opened into the vessel on both sides of the ligature." Mr. May goes on to say that the further appearances were instructive in view of the debateable questions surrounding the use of animal ligatures. With the exception of the hole corresponding to the knot, no part of the arterial wall was injured or divided, though under the ligature itself the wall was thinner than elsewhere. The inner coats were intact. It was obvious that the small chink which remained between the crumpled-up folds of the vessel, the remainder being occluded by adhesion of the inner coats, was closed by a moderately firm clot. A similar clot with conical end extended along the distal side of the artery nearly to its bifurcation. On the heart side there was a thin diaphragm of clot with a conical end, but extending a very inconsiderable distance. As the bulk of the hæmorrhage no doubt occurred here, some of the clot may have got carried out during life. The hole in the wall of the artery having been closed, it was shown, by injecting water, that the vessel was wholly occluded at the seat of ligature.

Turning from the results which bedside work has given to those of experiment, we are struck by the diametrically opposite conclusions at which workers have arrived as to the most useful form of ligature and the best means of tying it. This, though at first embarrassing, will be of less importance to those who, like myself,

hold that any evidence drawn from ligature of arteries in animals is of little value when applied to those of man. It is not only that (as we have daily opportunities of seeing) wounds and injuries in animals heal more readily and with much less risk of sepsis than in man, but evidence drawn from ligatures of *healthy* arteries in *healthy* animals must be received with much caution, the difference being very wide indeed between these cases and those where a ligature has to be applied in man for an aneurism, in patients past middle life, and with vessels no longer sound. Finally, any one who has tied the innominate in man for aneurism will hesitate to accept conclusions drawn from ligatures of like material, and tied in like manner on the carotids of sheep and horses. In addition to the objections already given, the two wounds are totally different. In the case of ligature of the carotid in animals we have a vessel which can be tied in healthy parts, well known for the rapidity with which they heal, and a wound which can be made with very slight disturbance of the soft parts. In the innominate, on the other hand, we have an operation beset with difficulties, often involving, from the presence of an aneurism, much displacement of parts, and a wound from its position, with its deepest part behind unyielding bone, most difficult to drain efficiently. I have spoken above of the diametrically opposed results at which those who have worked at the experimental side of this question have arrived. This is shown by the papers of Mr. Ballance and Mr. Edmunds, "The Ligation of the Larger Arteries in their Continuity: an Experimental Enquiry" (*Med. Chir. Trans.*, 1886, p. 443); "Ligation of the Great Arteries in Continuity, with Observations on the Nature, Progress and Treatment of Aneurism," 1891, and Mr. Spencer's "Experiments on Ligature of the Innominate" (*Brit. Med. Journ.*, 1889, vol. ii. p. 73). The first-named writers have arrived at the following conclusions: (1) That the operation of ligature of a large artery in its continuity should be performed without damage to its wall. (2) That the rupture of the coats of an artery during ligation in continuity is a useless and dangerous proceeding: useless, because the surgeon can secure the effectual occlusion of the vessel by a measure at once safer and less severe; and dangerous, on account of the possible occurrence of hæmorrhage or secondary aneurism at the seat of ligature, which could not happen if the wall of the vessel were uninjured by the ligature. (3) That, if the artery be diseased, the advantages attending ligation without rupture of the tunics are much magnified. It sometimes happens that the surgeon, on cutting down upon a large artery, observes a state of atheroma so extensive that he is obliged to close the wound and ligate a vessel nearer the heart, and thus expose his patient to considerably increased risk. There is no escape from such a dilemma under the system which declares that the arterial coats must be divided; but with a non-irritating aseptic ligature, so applied as not to lessen the power of the arterial wall, but actually to be a source of additional strength to it, the

question of ligation is seen under entirely new auspices, and the occlusion of a diseased artery would be undertaken with an assurance of success almost equal to that which obtains when a healthy vessel is in question. (4) That, when the coats of an artery are uninjured by the ligature, the danger of ligation near a large collateral branch is wholly avoided, because—(A) No danger can accrue from hæmorrhage when the wall of the vessel is intact; (B) The formation of clot, upon which the safety of the patient so much depends if the wall of the vessel be damaged, has really nothing to do with the adhesive changes which take place in a ligatured vessel; (C) The plastic actions which proceed at the place of ligation are practically alike, whether the tunics be ruptured or not. (5) That the ligatures employed in this series of experiments were probably in all cases larger than was absolutely necessary to secure the obliteration of the vessels. Comparatively speaking, they were not large. It would appear that a small round antiseptic ligature which will not become absorbed in less than three weeks, and which during that period holds firmly so as to cause a constriction of the arterial wall, and complete, or almost complete, obstruction of the cavity of the vessel, will so influence the nutrition of the part that permanent occlusion will follow. (6) That it is no more necessary to use a flat tape-shaped ligature (as recently revived by Mr. Barwell to prevent damage to the arterial coats during ligation) than to rupture the coats of the vessel. The small round ligature is the most easy to manipulate, and it is not difficult to learn to apply it in the manner here indicated. At p. 463 the above writers express a decided preference for kangaroo-tail tendon, as it is readily made aseptic, strong, of ample length, easily rendered as supple as silk by soaking it in tepid sublimate solution. Silk ligatures they consider difficult to render aseptic, probably on account of the recesses in which bacteria can lodge. Certainly when employed outside the peritoneum there is some uncertainty as to what will happen to silk. It may become encysted, or it may ulcerate out.

On the other hand, Mr. Spencer, from his experimental ligatures of the innominate in monkeys, concludes, that the best ligature is one of Chinese twist silk which has been kept in 5 per cent. carbolic acid, and boiled in that solution before being used. A silk ligature can be thus "rendered more thoroughly aseptic than any other without injuring its strength, and, being aseptic, it will remain quiet in position without relaxing. The ligature should be tied tight to divide the internal coats."

A third very interesting paper was read by Dr. Delépine and Mr. Dent before the Medico-Chirurgical Society, May 26, 1891. Its title, "The Changes observed in Healthy Arteries and in Tendon Ligatures during the first four weeks after Ligation," limits the deductions to be drawn from it as a guide in dealing with the human innominate. The authors advocate a tight ligature with division of the inner coats. It is clear from the

above papers that a healthy artery may be tied by either method successfully if aseptic precautions are adopted. As long as such authorities as Mr. Ballance and Mr. Dent differ so widely as to the mode of using the ligature the surgeon should keep an open mind in dealing with an artery like the innominate, according to its soundness or the reverse. In the case of an artery which is diseased, I think the balance of evidence is in favour of a tendon ligature tied tight enough to occlude the lumen, but not to injure the internal coats.

The question of using drainage is alluded to below (p. 529). Personally I may say that had I to tie the innominate again I should use kangaroo tendon,* or failing this, silk. Whichever was used I should endeavour to close the vessel securely, but considering the probability of degenerative changes in its coats and the volume of blood impinging on the ligature, I should try and use one short of that likely to divide the inner coats. As to drainage, if I succeeded in leaving a dry wound, I should be content to close it after dusting its recesses with Jeyes' powder or iodoform. If any oozing was going on, I should leave in for twenty-four hours a strip of iodoform gauze wrung out of carbolic acid lotion (1 in 20).

The truth is that these cases of ligature of the innominate in man are too few and far between to give us, for a long time, the only evidence on which we can rely. All other requires most careful weighing and checking before it is accepted.

At the present time, till we have further evidence bearing on the influence of modern surgery on this operation, we may say that there are cases which are clearly most inappropriate, and that there are certain special precautions which should not be neglected during and after the operation.

First, as to selection of cases, the following words of Mr. Holmes† should be remembered. The operation "should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-clavicular joint,‡ or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is more than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it be tied."§

The following are amongst the precautions indicated:

* This is preferable to ox-aorta, from the greater facility and the longer lengths with which it is procurable.

† *Syst. of Surg.*, vol. iii. p. 112.

‡ As Mr. Holmes remarks in a foot-note, "If the shape of the bones or joints is altered, it is clear that the aneurism arises in the thorax."

§ It is, however, very remarkable that in the cases of Porter and Aston Key, though it was found impracticable and undesirable to ligature the artery owing to its diseased and dilated condition, such changes were set up in the vessel by the exposure and manipulation as to lead to gradual cessation of the pulsation in the aneurism in one case, and its diminution in the other.

(1) Rigid antiseptic precautions persevered with till the wound is soundly closed. (2) Use of a flat ligature in securing the innominate probably diseased—viz., one of kangaroo-tail—with care, if possible, that the knot is not a hard one and does not press strongly on the side towards the artery. (3) Securing the carotid artery at the same time.* By this, in Mr. Spencer's words (*l.s.c.*), "a thrombus is then formed in the proximal end of the carotid, which extends to the bifurcation, and thus aids a thrombus in forming in the first part of the subclavian as far as the vertebral; otherwise the blood-flow will pass from the subclavian to the carotid close by the distal side of the ligature of the innominate, and so the operation will lack one of the important characteristics of a Hunterian ligation." (4) Obliterating the cavity as thoroughly as possible, after every care has been taken to check all oozing and to leave a dry wound, so as to prevent formation and collection of discharges.

Mr. Thomson, in his exhaustive account of his own case, states his belief that the fatal ulceration into the innominate was brought about by decomposition of discharges collecting at the bottom of the sinus left by the drainage-tube. This decomposition was, he thinks, due to the difficulty of keeping the dressings firmly on a movable part like the neck, to the fact that the skin heals much more quickly than the deep parts, and that the clavicle assists in preventing the soft parts coming together. He would, in future, use carefully adjusted sponges and shot-bags over them.

(5) Keeping the patient absolutely at rest till the wound is soundly healed, morphia being used subcutaneously, and any tendency to cough checked at once if possible.

LINE AND GUIDE. — The vessel, 1 to 2 inches long, extends along a line drawn from the middle of the junction of the first with the second bones of the sternum to the right sterno-clavicular joint (Holden). Its point of bifurcation varies somewhat.

RELATIONS :

IN FRONT.

Sternum ; sterno-hyoid ; sterno-thyroid.

Left innominate and right inferior thyroid vein.

Inferior cervical branch of right vagus.

OUTSIDE.

Right innominate vein.

Right vagus.

Pleura.

Innominate artery.

INSIDE.

Left carotid.

BEHIND.

Trachea.

Collateral Circulation.—This is thus given by Sir W. Mac Cormac (*Ligature of Arteries*, p. 75) :

* Ligature of the common carotid at the same time as the innominate will not necessarily prevent hæmorrhage, as was shown by Smyth's case, in which the carotid was tied at the same time as the innominate. Hæmorrhage occurred on the fourteenth day, and was repeated at intervals. The vertebral was ligatured on the fifty-fourth day, and recovery ultimately took place. Of five monkeys in which Mr. Spencer tied the innominate, the only one in which the carotid had not been tied died from hæmorrhage.

CARDIAC SIDE.

DISTAL SIDE.

Trunk.	{	First aortic intercostal,	with Superior intercostal of subclavian.
		Upper aortic intercostals,	with Thoracic branches of axillary and intercostals of internal mammary.
		Phrenic,	with Musculo-phrenic of internal mammary.
		Deep epigastric,	with Superior epigastric of internal mammary.

Free communication of vertebrals and internal carotids of opposite sides inside the skull. Communication of branches of opposite external carotids in the middle line of the face and neck.

Operation.—The patient, having been brought into as satisfactory a condition as possible by preparatory treatment, the head, body, and arm are placed as in ligature of the subclavian (p. 509). The surgeon, standing in front, makes an incision along the inner third of the clavicle, and another along the anterior border of the sternomastoid, meeting the first at an acute angle, each incision being upwards of 3 inches long (Fig. 134). The flap thus marked out is dissected up, the sternal and clavicular heads of the sternomastoid divided, and the sterno-hyoids and sterno-thyroids also carefully cut through on a director. This incision was made use of by Mott when he tied the artery in 1818. It appears preferable, as giving much more room in difficult cases, to any other. It has the serious disadvantage of dividing muscles which retract much and leave a large, gaping, deep wound, the difficulty of draining which has already been alluded to. I have mentioned one or two precautions which will, I believe, meet, in part, the above objection to this incision. Where the presence of a large aneurism with one or more processes to its sac increases enormously the difficulties of this operation, and thus calls for free access to the important parts dealt with, I am of opinion that this division of muscles will be found needful. Mr. Spencer, from his experiments on monkeys, advises the use of a single median, vertical incision, made as if for a low tracheotomy, retracting the sternomastoid, sterno-hyoid, and sterno-thyroid, opening the sheath and tying the carotid, and then following this down as a guide to the innominate. He argues rightly that if the muscles be retracted only, and not divided, when they are released, they will come together, so that no cavity is left in the deeper parts of the wound. Sound as this reasoning is, I fear there is no comparison between ligature of the innominate in monkeys and the same operation under the conditions which usually call for it in man. Every atom of room may be required, not only on account of the importance of the parts dealt with, the great enlargement of the veins, the presence of a dilated subclavian, a process of the aneurism extending inwards or a hugely expanded

vertebral as in my case (p. 532), but also because the surgeon may feel bound, as I did, to give his patient the benefit of a less risky operation, and thus be driven to divide the sterno-mastoid in order to examine the fitness for ligature of the second part of the subclavian. I would advise division of the muscles (in a case of any real difficulty), but at a point $1\frac{1}{2}$ inch above the clavicle. If they are divided just above this bone, the ends retract behind it, and I found the introduction of sutures impossible. My case also taught me that raising the skin and sterno-mastoid together, a precaution I adopted to secure a heavy flap, which will fall better into position, and thus help to close the deep wound, is a futile one, the contraction of the sterno-mastoid from above raising the skin with it. During these preliminary steps, one or two small arteries may be divided and some enlarged veins connected with the inferior thyroids drawn aside or tied with double ligatures, and, in reflecting the above-mentioned flap, the presence of the anterior jugular passing outwards beneath the sterno-mastoid just above the clavicle must be remembered.

The above muscles, when cut, being carefully held out of the way, and a layer of deep cervical fascia varying in strength divided, the pulsation of the carotid is defined, and its sheath opened to the inner side and as low down as possible. Other guides will be found, in the trachea and the subclavian artery, to lead the finger down to the innominate.

The carotid being traced down, the innominate will be found bifurcating into the carotid and subclavian. It is now that the real difficulties may be met with. (1) Owing to engorgement of the venous circulation, increased by the anæsthetic, the internal jugular and innominate vein may be so much enlarged as to protrude into the wound. (2) An aneurism may have extended under the artery and flattened it out so as to make it difficult of recognition. (3) The cellular tissue around the vessel and between it and the sternum may be so matted with adhesions as to make it difficult to define the artery and its important relations on the right side—viz., vagus, pleura, and right innominate vein. (4) The artery itself may be enormously diseased and expanded. (5) The bifurcation of the artery may be quite an inch below the joint.

In tracing down the innominate itself, the surgeon must keep his steel director most carefully on the front of the artery. In following the vessel down behind the sternum in order to find a site for his ligature, he will be aided by slightly flexing the head and by a laryngeal mirror, or electric light. The cleaning of the artery must be done with the utmost caution, especially on the outer side, owing to the important structures lying there; of these the innominate vein and the vagus may be drawn outside, but it is only by keeping the director or needle-point very close to the artery here that injury to the pleura can be avoided.

If there is doubt as to the position of the artery, pressure with

the finger behind the vessel against the sternum will arrest the pulsation in the carotid and the aneurism. If the bifurcation of the artery lie, as in my case, a full inch below the joint, attempts should be made, by pulling up the carotid protected by a piece of aseptic gauze, to raise the bifurcation sufficiently for the passing of the ligature. I believe this to be preferable to dragging on the vessel by the ends of a ligature previously tied round the carotid, and left long. If it is impossible thus to raise the bifurcation sufficiently, the inner $1\frac{1}{2}$ inch of the clavicle must be removed by disarticulating and sawing through the bone.

The needle should be passed from without inwards and a little from below upwards to avoid the pleura. In this case, as in that of the subclavian and other deep-seated arteries, the surgeon will do well to provide himself with needles of different curves (of these the late Mr. Durham's needle, in which the curve is twisted laterally at a right angle to the shaft, is a very helpful one), or with a silver probe sufficiently flexible to take any curve and with a large eye close to the point (p. 512).

The needle should be loaded with thoroughly aseptic silk, or, if it be preferred to this, after it has passed, a flat ligature of reliable kangaroo tail, should be secured, and then pulled beneath the vessel. It should be tied firmly, as I believe that these ligatures, after soaking, are so supple as not to cut into the vessel (p. 522). Care should be taken to keep the ligature flat around the artery while tying it, and the knot as little projecting (especially towards the vessel) as possible. In addition to the amount of force used, the surgeon will derive some information as to the extent to which he has constricted the vessel by watching the aneurism, all pulsation in which should have ceased.

The ligature being tied and cut short, the common carotid should be tied also, about $\frac{1}{2}$ inch above its origin. If the thyroidea ima arise from a point at which it is likely to bring in a reflux current which will dangerously disturb the clot, on which so much depends, this vessel should be tied also.*

The wound is now carefully cleaned and dried, the severed muscles carefully united with chromic-gut buried sutures, hæmorrhage most scrupulously stopped, a drainage-tube inserted,† and the wound carefully closed. If the patient will bear it, the limb, previously wrapped in cotton-wool, should be secured to the side

* This was the case in Lizars' patient (*Lancet*, 1837, vol. ii. pp. 445, 602; Spencer, *loc. supra cit.*).

† If it is possible to suture the cut muscles satisfactorily, and thus close the deepest part of the wound after this has been carefully dried out, a drainage-tube may be dispensed with. If the surgeon, wishing to be on the safe side, especially where the parts have been much disturbed, makes use of a tube, it should be removed, if possible, at the first dressing. I followed this course in my case on the day after the operation. When the patient died, on the tenth day, the wound was found at the autopsy perfectly sweet and free from any collection of fluid (p. 533).

and chest, and every attempt made, by elastic bandaging and a shot-bag, to keep the dressings firmly in place, and thus promote, from the first, steady adjustment of the parts and sound healing. Morphia should be used as freely as is safe, to diminish, as far as possible, the sensibility of the patient to the irksomeness of his position. The slightest tendency to cough should be treated at once. The absolute need of rest and quiet should be enforced upon the patient until the wound is soundly healed.

I am enabled, through the courtesy of Mr. Banks, to give an abstract of a most interesting case of right subclavian aneurism in which the innominate and, subsequently, the first part of the subclavian were tied. Owing to the exceeding rareness of recovery after ligature of the innominate, and the survival of a patient for thirty-six days after the placing of a ligature round the first part of his subclavian, it is to be hoped that this most instructive case will be published *in extenso*.

J. B., aged fifty, was admitted into the Liverpool Royal Infirmary, February 10, 1883, with well-marked symptoms of aneurism of the third part of the right subclavian. Attempts to treat the patient by rest, &c., having failed, owing to his obstinately persisting in getting up, the innominate and common carotid were tied, February 26, with the strictest antiseptic precautions. The earliest steps presented nothing remarkable. "Unluckily, the bifurcation was quite $\frac{1}{2}$ inch lower than it ought normally to be, and this caused some difficulty in getting the aneurism needle round the vessel. I used a needle of the ordinary kind, having a large curve, and threaded with silk. There was about a minute of rather anxious work while the needle was being tickled through the tissues surrounding the vessel, a proceeding which was accomplished solely by feeling, as the artery lay too deep for me to see anything that could aid me. By means of the silk thread, a stout kangaroo-tendon ligature was pulled beneath the vessel, then tightened, three knots being placed upon it. I applied the amount of force which I thought would be necessary completely to occlude the artery, but not to damage its coats, and I felt very certain that I had made a thorough and satisfactory ligature of the artery. Whether I really did so or not is a question. . . . The aneurism ceased to pulsate. I next proceeded to pass a ligature round the common carotid. . . . Being engrossed in this, I took no further notice of the aneurism. But those who were assisting saw that, after an interval of about two minutes, a certain amount of pulsation returned in the aneurism. I imagined that this must have arisen from the retrograde circulation along the common carotid and subclavian, and so proceeded at once to tighten the ligature (another kangaroo tendon) round the former vessel. As soon as this was done, the pulsation in the aneurism again became practically imperceptible."

A slight return of pulsation was noticed in the evening of the operation.

The restlessness and irritability of the patient during the first few days were frightful. He tossed about the bed, moved his arm as much as the bandages would allow, loudly demanded stimulants, and swore at everybody about him. He was not, however, in the least feverish or delirious. Practically there was never any suppuration, and the extensive wound healed by primary union. All dressings were discontinued on the thirteenth day, and the patient, who had insisted on getting up on the ninth, went out on the twentieth day with the wound sound.

Unhappily, the pulsation feebly present in the aneurism on the evening of the operation became strong and accompanied with thrill by the third day. Pressure with a bag of shot was tried, but the patient, by his unruly behaviour, did all he

could to prevent any consolidation occurring. When the patient went out the aneurism was quite as soft, and the pulsation and thrill quite as obvious as before. It very soon decidedly increased, spreading out under cover of the trapezius and pushing inwards the scalenus anticus. "At the end of five weeks it became clear that either the aneurism must be left alone and the man abandoned to his fate, or that something more must be done. But what? Galvano-puncture and the introduction of wire or other material into the sac have not proved of sufficient utility to entitle them to be considered satisfactory methods of treatment at the present moment, whatever may become of them in the future. Ligature of the first part of the axillary on the distal side of the tumour is not any better. To lay open the aneurism and attempt to secure the artery on either side of the aneurismal opening would almost certainly have been fatal on the spot. To go down through the old cicatrix in search of the innominate, with a view of tying it a second time, seemed very impracticable. Besides, I could not be any more certain of curing the aneurism the second time than the first. The only thing that remained was to tie the first part of the subclavian. Sixty-seven days after the ligature of the innominate I performed this operation, not using the spray during the dissection, lest it should obscure one's vision, but turning it into the wound after the vessel was tied. By this date the tumour had so increased in size that there was just room on its inner side, and no more, to get at the artery. An incision was made along the hinder margin of the sterno-mastoid, and another extending from it outwards along the clavicle. After getting through the superficial structures, the clavicular portion of the sterno-mastoid was divided, and the internal jugular was followed down to its junction with the subclavian. Here, in consequence of the matting together of parts as a result of the first operation, it became almost impossible to know what one was dealing with, and an unpleasant accident occurred. I tore across a vein of some size close to the point where it entered the angle of junction of the jugular and subclavian. Instantly a rushing and hissing noise showed that some air had got into the venous trunks, and for a brief space the situation was uncomfortable. A finger was put on the aperture, and to our relief the patient showed no signs of being in any way affected by the occurrence. The aneurism covered by the thin fibres of the scalenus anticus next came into view. My colleague, Mr. Harrison, gently but steadily pushed this outwards with a couple of fingers, and in the very limited space between this and the internal jugular I proceeded to search for the artery, guided by its pulsation. Very slowly, and after an infinity of anxious picking and teasing (for one dared not use a knife), this was exposed about $\frac{1}{2}$ inch from the aneurism. The vessel was obviously thinned and dilated, and this added immensely to the danger of passing the aneurism needle beneath it. The needle was threaded with a silk ligature, which drew after it a double catgut ligature. The loop of this being divided, the artery was secured by both portions lying side by side. The knots were drawn very gently, with the intention of merely closing the artery and not of injuring any of its coats. The aneurism at once became still.

"A very few lines have sufficed to describe this operation, but it took more than an hour to perform, while the difficulty, danger, and anxiety that attended it are almost impossible to describe. Owing to the fact that the parts had already been interfered with, there was a great deal of thickened and cicatricial tissue present. Cutting this was out of the question, as it was impossible to say what was adherent to or mixed up with it. It had, therefore, to be pulled asunder fibre by fibre, with the aid of strong forceps and a dissecting tool. As the operation advanced, the depth at which one had to work became greater and greater, while, in order clearly to make out the various structures, the wound had to be kept absolutely free from blood. Sometimes minutes would be lost in picking up some trifling vessel from which just enough blood would keep welling

to obscure the wound. The space in which anything could be done was of the most limited description, and surrounded by dangers on every hand. To the outer side was the bulging aneurism, to the inner was the internal jugular, below lay the subclavian vein, and immediately beneath the artery itself was the pleura. . . . Compared with this performance, tying the innominate was a mere surgical amusement, and I should never care to repeat it again."

The patient rallied well from the operation, but a few days later developed an attack of broncho-pneumonia, which exhausted him extremely. He slowly rallied from this, but the wound gaped widely. It ultimately healed, save for a sinus, which admitted a probe deeply. On the twenty-third day the patient got up, and by the thirty-first day had been out in the open air. On the evening of this day hæmorrhage occurred from the sinus, frequent recurrences took place, and the patient died on the thirty-seventh day after the operation. By the fourth day the aneurism had no trace of pulsation, and was small and hard.*

The following case of ligature of the innominate which was under my care well illustrates some of the difficulties which may be expected.

A. H., aged forty-eight, was sent to me by Dr. Lockhart Stephens, of Emsworth, February 1890. Occupying all the lower part of the posterior triangle, and to be felt in the axilla and between the heads of the sterno-mastoid, was a large aneurism, 6 inches \times 4 inches. There was no evidence that the innominate itself was involved. Patient had first noticed the swelling a year before, when it was about the size of a walnut. He had been doing his work as a gamekeeper, and shooting rabbits, till two weeks before his admission, February 10. Chloroform being given, the parts cleansed, and irrigation with hyd. per. 1-2000 employed throughout, an incision $3\frac{1}{2}$ inches long was made along the anterior margin of the sterno-mastoid, and another transversely outwards, just above the clavicle, over both heads of the sterno-mastoid, to a point over the inner part of the aneurism. The skin and both heads of the sterno-mastoid were divided together, with the hope of thus keeping the skin down better when the wound was closed, and thus better obliterating the large wound and ensuring earlier healing. The sterno-hyoid and sterno-thyroid being divided, two very large inferior thyroid veins secured, and the internal jugular drawn outwards, the inner part of the carotid sheath was opened and this artery traced down to the innominate. The chief difficulty at this stage was due to what was thought to be a pulsating process of the aneurism, which extended inwards under the jugular and carotid, but was really a hugely dilated vertebral. The carotid being traced down, it was found impossible to pass a ligature below the bifurcation, which lay a full inch below the joint. In spite of the aid given me by Mr. Davies-Colley, who drew up the carotid protecting the vessel with a bit of lint wrung out of carbolic lotion, I was unable to get my finger or a director sufficiently deep behind the clavicle to make sure of being below the bifurcation. I accordingly removed the inner extremity of the clavicle, disarticulating and sawing through the shaft. I was now able, aided by Mr. Davies-Colley's most efficient help, to bring just the top of the bifurcation into view. More than this was impossible, and the aneurism needle (one of corkscrew form lent me by Mr. Durham) was passed by touch round the innominate from without inwards. It was previously loaded with silk, to which a piece of ox-aorta ligature, kindly provided by Mr. Barwell, was knotted. In tying the vessel, I tried to use force sufficient to close it, but not to injure its coats. Judging from the outside, the walls were well puckered together. Pulsation in the aneurism ceased at once, and never returned. The carotid was then tied, with a similar ligature, about an inch above its origin, not only to prevent

* The notes of this case contain no mention of an autopsy.

any efflux of blood through it, but also because the vessel was probably weakened by much handling. The wound was thoroughly dried out, and dusted with iodoform, a drainage-tube inserted, and the wound united by twelve salmon-gut sutures. By the third day the aneurism began to shrink markedly, but the following night the patient began to be restless and delirious, and this increased and persisted. The delirium was peculiar. He was incessantly restless, trying to get out of bed, chattering without ceasing, calling to his dogs, &c. It was most difficult to keep his right arm still, and before long it was needful to secure him with straps. Morphia, sulphonal, chloral, chloralamide, hydriodate of hyoscyamin were all tried with very little result. There was also evidence of broncho-pneumonia at both bases. The restlessness and chattering delirium continued, and, in spite of the abundance of food taken, the strength became exhausted, and the patient sank on the tenth day. The wound remained quite sweet throughout. At the post-mortem examination the wound was perfectly sweet, without a trace of pus, and levelling up well. A large sacculated aneurism occupied the second and third parts of the subclavian and the first and second parts of the axillary. In addition to the main sac, which occupied the posterior triangle, a hemispherical dilatation projected into the upper part of the right pleura. Encircling the innominate, just below the bifurcation, which was on a level with the first costo-sternal articulation, was the remains of a ligature, but no knot could be found, and the ligature was movable with the point of a director. Surrounding the bifurcation of the innominate was a small cavity, from which could be squeezed not more than a drachm, if so much, of quite sweet pus-like fluid. The carotid had been tied about $\frac{1}{4}$ inch above the top of the sternum, and here, too, the wall of the vessel was very soft, so that in dissecting it a hole was made in the vessel above the ligature. The knot, however, had held well in position. Running behind the carotid sheath, and given off from the subclavian immediately after its origin, was a long fusiform dilatation, which was probably the vertebral much dilated, as large as the forefinger. A small window being cut in the aneurism showed that this was filled with a greenish-tinted, jelly-like coagulum, not blood-stained, and traversed in every direction by isinglass-like threads. The only remnant of a cavity was quite at the back part, where a space into which the tip of the finger could be introduced contained a little fluid blood. The inner aspect of the sawn clavicle was smooth with granulations save just at its upper part. The pleuræ were absolutely healthy. Both bases were the seat of broncho-pneumonia. The mediastinal connective tissue was extensively occupied with air: this had not penetrated beneath the pulmonary pleura, nor produced interstitial emphysema. The aortic and mitral valves, the latter especially, were diseased; the aortic arch was the seat of atheroma, dilated uniformly, irregular on the surface and rough internally, but not calcareous. The abdominal aorta was very bad, full of calcareous plates. The kidneys showed early interstitial nephritis. There was a small hard mass of clot in the innominate, below the ligature; little in the carotid. The brain was normal.

Causes of Death after the Operation.—It may be expected that most of these will, with antiseptic precautions, disappear, viz. :

1. Suppurative cellulitis and mediastinitis.
2. Lung trouble—*e.g.*, bronchitis, pleuro-pneumonia.
3. Pericarditis.

There still remains the terrible complication of secondary hæmorrhage, which has occurred, as yet, in almost every case, and has always proved fatal, save in the case of Dr. Smyth.

Secondary hæmorrhage may occur up to the sixtieth day, as in

Graefe's case. It has already been discussed how far modern surgery is likely to prevent this, and certain precautions have been enumerated at p. 525. The treatment as shown is mainly preventive. When once bleeding has occurred, little can be done beyond tying the vertebral and common carotid, if this has not already been done, and plugging the wound with iodoform gauze wrung out of carbolic-acid lotion (1 in 20,) or turpentine (p. 468), and putting on pressure with shot-bags.

SURGICAL INTERFERENCE IN ANEURISMS OF THE INNOMINATE AND AORTA.

While the distressing nature of these cases justifies a resort to surgery when medicine fails, I would point out (1) That the surgeon is often called in too late, in large thoracic aneurisms where treatment of any kind is certain to be unsatisfactory.* (2) That, with regard to the amount of relief which surgery can fairly be expected to give, when the large number of cases published and unpublished which have been treated surgically in the last few years are duly weighed, it is clear that permanent cures are extremely few, and that while in some cases decided relief is given, in many—published at the time as successes—were the sequel followed up, it would be found that very little real relief had followed, while in not a few, what with the risk of the anæsthetic, the excited circulation, the partial cure of the aneurism at one part, and the tendency set up to spread at another spot, possibly less able to bear the strain, and perhaps with more important surroundings, surgery has not only failed to check but has actually hastened the progress of the aneurism.

The advisability of resorting to surgical means will be considered under the heads of—A. Diagnosis; B. Treatment, the latter including—(i) Ligature; (ii) Introduction of Foreign Bodies; (iii) Galvano-puncture.

A. Diagnosis between Innominate and Aortic Aneurisms.—It is well known how extremely difficult this matter is; the expression of a confident opinion is, too often, quite out of the question (p. 537). While a precise diagnosis is usually impossible, no pains should be spared in going into all those points which may help in deciding how far the aneurism is probably limited to the innominate or to the aorta, and, in the case of this vessel, which piece of the arch is chiefly encroached upon, for it is only by paying attention to the above points that answers can be given to the two questions which arise—viz.,

* The fact has been too much lost sight of that large thoracic aneurisms, with their size, varying degree of sacculation, restricted power of collapse and important surroundings, are on quite a different footing for operative interference to aneurisms of the extremities. Further, the disease here is much less often a local one.

(1) Is any operation justifiable at all? (2) If an operation is justifiable, what is it to be?

Chief Points to pay Attention to in Diagnosis.

1. *The Position of the Aneurism.*—This is obviously only of value in a few cases, when the patient is seen early, or when he can be relied upon for an intelligent history of his case. Mr. Wardrop's rule was, that innominate aneurism first presents itself to the inner side of the right sterno-mastoid, carotid aneurism in the interval between the two heads, and a sub-clavian one to the outer side of the muscle. Mr. Barwell* writes of the first of the above thus:—"The tumour of an innominate aneurism generally occupies the episternal notch, but chiefly on the right side, and, even though it may not rise high, takes up the whole breadth of this space. On gently pressing the finger backward and downward, the rounded margin of the sac can be felt. After a little time the sternal end of the clavicle protrudes abnormally, and partakes in the pulsation (communicated), while the sternal and, afterwards, the clavicular portion of the sterno-mastoid are also pushed forward. Not unfrequently the first costal cartilage, outside where it joins the sternum, is also abnormally prominent, and throbs with the beat of the tumour."

Mr. Heath thus describes (*Dict. of Surg.*, vol. i. p. 81) the possible points of appearance of an aortic aneurism: "If on the ascending portion of the arch, the sac presses against the sternum, producing gradual absorption of the wall of the chest, and communicating a marked impulse to the right side of the sternum as high as the sterno-clavicular joint, which may be invaded by the tumour in the later stages. If on the transverse portion of the arch, the sac encounters but little resistance in an upward direction, and hence is apt to invade the inter-clavicular notch, to compress the trachea and occasionally the œsophagus, and to produce marked spasm of the larynx by interference with the left recurrent laryngeal. When a sac of this kind rises into the neck, it is a matter of uncertainty to which side it should be allotted, since a tumour projecting most to the right by no means necessarily *originates* on the right side and *vice versa*."

2. *The Pulse.*—If a decided diminution is found in the right radial and carotid, the aneurism is probably of the innominate; but an aortic aneurism near the root of the innominate will bring about the same result.

3. *Pressure Symptoms.*—These will vary with the position as well as the size of each form of aneurism. Thus, in innominate aneurism pressure symptoms will vary according as it is high up or low down, and pressing inwards or outwards. As to œdema, the value of this must remain undecided while surgeons hold such opposite views.

Thus Mr. Heath* and Sir J. E. Erichsen† speak of œdema of the right side

* *Intern. Encycl. Surg.*, vol. iii. p. 507.

† *Loc. supra cit.*

‡ *Surgery*, vol. ii. p. 75.

of the neck and upper limb as first noticed. Mr. Barwell,* on the other hand speaking more particularly of the low form of innominate aneurism (usually combined with aortic disease), writes: "The point to be especially remarked is this—the pulsation, dulness, abnormally loud heart sound, &c., are on and to the right of the middle line; the venous congestions are on the left side of the body; nor does the right participate till late in the disease. . . . When the right side is also involved, the aneurism will have become large."

I cannot find that the other pressure symptoms—viz., laryngeal or tracheal dyspnœa, irregularity of the pupil—are really distinctive between innominate and aortic aneurism.

Mr. Barwell considers that the following combinations of symptoms "furnish remarkably positive evidence" in aortic aneurism: "For instance, pressure wholly and entirely on the right bronchus; congestion of both arms and both sides of the head and chest; tumour symptoms, chiefly about the second space and rib, considerably to the right of the sternum; heart displacement, if any, directly outward; the pulses equal . . . indicate disease of ascending aorta. Congestion of the left arm, supra-clavicular region, and side of the head; aneurismal character of right pulse (radial and carotid); tumour symptoms a little to the right of the sternum, and probably some tracheal dyspnœa, are symptomatic of aorto-innominate aneurism. Modification of left radial pulse, affection of left vocal cord, left venous congestion, tracheal dyspnœa, and obstruction of air to both lungs, with tumour symptoms on and to the left of the median line, mark disease of the transverse aorta. Obstruction to the entrance of air to the left lung alone, with pains at the back and along the intercostals, is indicative of disease of the third part of the arch."

4. *Displacement of the Heart Downwards*.—The more marked this is the greater is the probability that the aneurism is aortic.

Difficulties and Fallacies in the Diagnosis.

1. The proximity of the heart. "When there is a bruit, it is extremely difficult to distinguish whether it is limited to the tumour or is propagated into it from the cardiac valves; whether the pulsation is limited to the neck, or extends also into the thorax; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated."

2. "The growth of aneurisms in the cellular tissue of the mediastinum and root of the neck is so free that instances have been observed of aneurisms of the arch of the aorta causing compression of the subclavian and carotid, without any disease of those vessels; while, on the other hand, if the aneurism approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased" (Holmes †).

3. The distribution of the branches of the aorta may be anomalous.‡

* *Loc. supra cit.*

† *Syst. of Surg.*, vol. iii. p. 14.

‡ Mr. Holmes quotes the following instructive case: In a patient in whom,

The following remarks of Mr. H. Morris on a case of aortic aneurism illustrate the extreme difficulty of diagnosis here :

No one who examined this woman questioned that the aneurism was innominate, and some very capable diagnosticians considered it to be a simple sacculated aneurism of that vessel. Even after dissection it was impossible to make out its true character until the sac had been laid freely open in front, and the innominate artery behind. The situation and outline of the tumour, the pain in the shoulder and over the right side of the head and neck, led to the diagnosis of innominate aneurism. The origin of the disease from the aorta might have been suspected if more weight had been given to the severe *gnawing* pain across the front of the chest suffered at the onset ; to the dilated veins on the right side of the upper part of the chest ; to the equality of the radial pulses ; to the absence of any cough, dyspnoea, and throat dryness, of any deflection of the trachea, of any numbness or loss of power in the right arm (such frequent symptoms in innominate aneurism) ; and to the fact that aortic aneurism causes tumours in the neck.

B. Treatment.

I. LIGATURE.*

Aids in selecting Cases fitted for Operation.—Mr. Barwell (*loc supra cit.*, p. 520) writing on innominate aneurisms, has formulated the following aphorisms :

i. An aneurism commencing suddenly, especially if traceable to some over-exertion, is more likely to be benefited by operation than one arising gradually and without mechanical cause. ii. Distinct sacculation is a most desirable condition ; fusiform dilatation of the innominate indicates almost certainly a similar condition of the aorta and widespread arterial disease. iii. If symptoms show the aortic arch to be also affected, the disease should be limited—that is, should not extend along the transverse portion. It should be of the sacculated variety, not a general dilatation of the whole calibre. Absence of any other aneurism, especially of the rest of the aorta, must be ascertained. iv. Absence of rasp-sound along the aorta, or any other indication of extensive atheroma, should be verified. v. Aortic incompetence, unless very slight, is a decided objection, as is also mitral disease, or considerable hypertrophy of the heart. vi. The patency of the vessels leading to the brain should be investigated by making a few second's pressure on the carotids alternately and then simultaneously. vii. Absence of visceral disease must be ascertained.

Before deciding to recommend operative interference in these aneurisms, the surgeon should, I think, consider most carefully the following points, which appear to me to be the outcome of recorded cases :

from other symptoms, there was no difficulty in diagnosing an aneurism of the arch of the aorta, one circumstance was difficult to account for—viz., that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death the right subclavian was found to be the last branch of the aorta. Passing between the aneurism and the spine it had been compressed, while the carotid was unaffected.

* Many of the remarks below apply also to the two other methods of surgical interference—introduction of foreign bodies into the sac and galvano-puncture.

1. It is possible that too much importance has been attached to a very few successful cases, and that too little attention has been given to the fact that numerous unsuccessful cases have occurred which have never been published.

2. It is certain that, in some cases, operative treatment may not only fail to check the progress of the aneurism, but may actually and decidedly hasten the fatal issue. This grievous result may not only be brought about by the difficulties of the operation itself, but also by this special and untoward result which is common to all operative treatment here—viz., that, as in these aneurisms the contiguous part of the large vessels (aorta especially) is often extensively diseased, and as other aneurisms may be present, ligation of one vessel, by checking the flow of blood at one part, may throw the current suddenly upon another, perhaps unfit to bear the strain, or from its relations, more likely to produce grave pressure-symptoms.* Sufficient attention has not been paid to this most important point.

“If the enormous difficulty of diagnosis, the great risks of the operation, the possibility of spontaneous improvement, if not of cure, and of palliation by rest and diet, and also the fatal results of recorded operations, be taken into due consideration, it seems that the distal ligation on the right side should be limited to desperate cases, and then performed only with the expectation of relief, not of cure” (Morris†).

Contra-indications to Operative Interference.—Mr. Barwell (*loc. supra cit.*, p. 528) lays down the following: (1) When tumour symptoms reach widely on both sides of the middle line; (2) when, with paralysis of the left vocal cord, there is obstruction of the right bronchus; (3) when there is evidence of considerable aortic incompetence; (4) when there is mitral disease or considerable cardiac hypertrophy; (5) when there is, in the course of the aorta, the rasping sound of calcification or advanced atheroma, more particularly if the superficial vessels are rough and rigid; (6) when there is pain about the spine and intercostal nerves; (7) when there is obstruction of the left bronchus only; (8) when there is pressure on the left apex, and expectoration of frothy blood.

Choice of Vessel.—**Question of Simultaneous or Consecutive Ligation.**—I have no space here for quoting statistics, which are, after all, of inferior value to the authoritative opinions of those who have worked most at this subject. The earliest and foremost of these is Mr. Holmes; as it is to his opinion that English surgeons will naturally turn, the most important of his views are given here.

* The rapid extension of the aneurism in another direction after its original growth has been checked by operative interference is well shown by a case of Dr. Churton's (*Clin. Soc. Trans.*, vol. xix. p. 261), in which, subsequently to galvano-puncture, the blood-pressure found out other weak spots in addition to the original aneurism, thus bringing about other sacular projections and fatal rupture into a bronchus.

† *Loc. supra cit.*, p. 103.

1. "One thing, I think, has been fully proved—viz., that the distinction which was so much insisted on between aortic and innominate aneurism is of less importance in regard to the distal operation than used to be taught, and that a case of innominate aneurism which otherwise seems appropriate for operation need not be rejected because it is suspected or known that the aorta is also involved. It has also been satisfactorily proved that aneurisms purely aortic have been much benefited by distal operations. It remains to inquire what cases should be selected, and what arteries should be tied in each case."

2. "To my mind the clearest evidence of benefit has been in the case of ligature of the left carotid in the treatment of aneurism affecting the transverse part of the arch." In a case of this kind it was the evident extension of the tumour up the neck and towards the trachea which made Mr. Holmes think that the ligature would prove beneficial, and the result even surpassed his expectations, the patient being alive and in tolerable health five and probably seven years after the operation. Thus Mr. Holmes, considering that the applicability of the distal ligature depends largely on the observed growth of the tumour, would think ligature of the subclavian justifiable if, in innominate or mixed aneurism, the tumour was making rapid advance under the sterno-mastoid. He also draws attention to the importance of estimating pressure-signs as indicating extension of the aneurism, as evidenced by the condition of the veins, the breathing, the pupil, &c. (p. 535).

3. With regard to operations on the right side in cases of innominate or mixed innominate and aortic aneurism, opinions vary as to whether the carotid or subclavian should be tied simultaneously, or whether the carotid should be tied first. Mr. Holmes, who holds this latter view, evidently thinks that ligature of this vessel may be sufficient without any consecutive ligature of the subclavian, unless indications arise—*e.g.*, the manifest growth of the subclavian portion of the sac, or the effect of compression of the subclavian in diminishing the size or the pulsation of the tumour.

Mr. Holmes' chief reasons for preferring ligature of the carotid alone as a first step are—(a) that while the number of cases of simultaneous ligature is much the larger, the most striking instances of success have followed ligature of the right carotid alone; (b) in some cases, where ligature of the subclavian has been also resorted to later, the aneurism was already diminishing and becoming firmer after ligature of the carotid; (c) the simultaneous ligature of two such vessels as the carotid and the subclavian may be a very formidable undertaking from the prolonged dissection and difficulties with the anæsthetic; (d) as ligature of the left carotid has proved sufficient in aortic aneurism, a similar step should be tried on the right side in innominate aneurism.*

* Mr. Barwell (*loc. supra cit.*, p. 328) goes a good deal further as to the points which he believes will serve to guide the choice of the surgeon. Time alone will show how far these are reliable.

Another interesting and unsettled question bearing on the matter of ligature of large vessels near the heart is the most appropriate material for ligature. This has been already discussed (p. 521).

Facts which show that the resort to Ligature has been justifiable.

(1) Solidification and diminution in the size of the swelling
(2) Diminution of pulsation. In one case of Mr. Barwell's (*Med. Chir. Trans.*, vol. lxviii. p. 130), a month after simultaneous ligature of both arteries for innominate aneurism, the swelling again began to increase and the solidifying tumour to soften, pulsation also recurring; this went on for about two weeks, when the swelling again solidified and decreased, recovery ultimately taking place. (3) Improvement in dyspnoea, dysphonia, and dysphagia. (4) Regain of power over a limb. (5) Expectoration of mucopurulent discharge which has been accumulating in the lungs owing to interference with expiration from pressure on the trachea.

II. INTRODUCTION OF FOREIGN BODIES INTO THE SAC—A. WIRE. HORSEHAIR, ETC.—This method was originally brought before the profession by Mr. Moore (*Med. Chir. Trans.*, vol. xlvii. p. 129), who introduced 26 yards of fine iron wire into an aortic aneurism. No relief followed, inflammation of the sac set in, and the patient died five days later.

More recently, Dr. Cayley has published a similar case in which 40 feet of wire were introduced by Mr. Hulke. Some relief was given to the pain, and some consolidation had evidently taken place, but extension followed in another direction, causing urgent tracheal dyspnoea. On this account wire was introduced a second time, 34 feet being got in. Death followed nine days later. Owing to this material being considered too irritating, it has not been much used.

Other surgeons have made use of catgut and horsehair, but with these less irritating substances the great difficulty is to get much into the sac, as they readily bend on themselves in the cannula.* In the summer of 1887, in a patient of Dr. Pye Smith's, with a large aortic aneurism coming through the chest wall. I introduced about 40 feet of horsehair by means of an ingenious method suggested to me by Dr. Perry. No good was done, the patient dying shortly after, worn out with pain. The post-mortem examination showed that the clot formed by the horsehair was too localised to have effected much in the huge cavity formed by the aneurism.

* I know of one case in which specially prepared very long pieces of catgut were introduced into an aneurism in the neck. At the post-mortem some of these were found to have passed on, beyond the aneurism, into the splenic artery. In the *Ann. of Surgery*, vol. iv. No. 2, a case of Dr. Ransohoff, of Cincinnati, is recorded, in which 96 inches of flexible silver wire were passed into an aneurism of the aortic arch. After the first 48 inches had been introduced, syncope, with impending death, set in. With the aid of stimulants, the operation was completed. For a fortnight the symptoms were improved, when œdema of face and right arm appeared; 98 inches of wire were then passed into another part of the sac. The patient died eight days later, from rupture of the aneurism. The syncope was found to have been caused by a loop of wire which had passed beyond the neck of the sac into the aorta, where it was probably deflected by the aortic valves.

B. NEEDLES.—This method, as I wrote four years ago, is more deserving of trial.

Suggested by Mr. Moore, it has been tried by Prof. Macewen, Mr. Heath and Mr. Puzey.* Mr. Heath made use of it in a traumatic aneurism of the subclavian, where amputation at the shoulder-joint had failed. Three pairs of sewing needles were introduced into the tumour, each pair being made to cross in the sac; they were not withdrawn until the fifth day, by which time considerable clotting had taken place. The aneurism gradually became solid; but bronchitis supervened, and the patient sank seventeen days later. Mr. Puzey followed Mr. Heath's plan in an aneurism of the innominate, but, no apparent effect taking place at the end of four or five days, other needles were inserted as the first were withdrawn, but at different parts of the swelling. This procedure being carried out for several weeks, the aneurism finally almost disappeared behind the sternal end of the clavicle. Unfortunately, the needles set up some chronic cellulitis, septicæmia followed with vomiting, and fatal rupture of the sac. Mr. Puzey thinks this case affords a warning against pushing this treatment too far, and that it would be better to wait patiently the results of the first introduction of the needles before proceeding to insert others.

Prof. Macewen, who used this method first as long ago as 1875, has published (*Lancet*, 1890, vol. ii. p. 1086) a most interesting paper on the use of pins to secure the formation of thrombi, and so the cure of aneurism.

"The instrument employed is a pin of sufficient length to completely transfix the aneurism and to permit of manipulation within it. Its calibre ought to be as fine as possible, the strength being only sufficient to penetrate the coats of the aneurism and the intervening tissues. This cylindrical pin tapers to a point, like an ordinary sewing needle, and has on its opposite extremity a somewhat rounded head. As the coats of aneurismal sacs vary in thickness, these pins must be made of various calibres. They ought to be finely polished, not only to facilitate their introduction, but to help to render them aseptic. Before performing the operation, the skin over the aneurism ought to be carefully cleansed and rendered aseptic. The aseptic pin ought then to penetrate the sac and pass through its cavity until it comes in contact with the opposite side. It ought to touch this and no more. Then one of two methods may be employed: either to move the pin over the surface of the inner wall so as to irritate its surface, or to allow the influence of the blood current playing on the very thin pin to effect the same object. If the walls penetrated by the pin be dense, the former method will be preferable, as the force of the blood-current produces such a feeble action on the thin pin as to be insufficient to move it to and fro while it is firmly grasped by the dense wall. After acting thus for ten minutes at one part, the point of the pin, without being removed from the sac, ought to be shifted to another spot, and so on until the greater portion of the internal surface opposite to the point of entrance has been touched: this ought to be done in a methodical manner. A single insertion of the pin through the sac into its interior may be sufficient to enable the

* Art. "Acupuncture," *Dict. of Surg.*, vol. i. p. 25.

point of the instrument to come in contact with the greater part of its internal surface, but, in some cases, puncture from various sides of the external wall may be necessary so as to reach portions of the tumour which cannot be attacked from the first puncture. While the pin is in the aneurism, it is surrounded by a portion of aseptic gauze, or moistened with an antiseptic lotion. When it is withdrawn from the aneurism, the part ought to be covered with moist antiseptic dressing, which ought to be maintained for several days. The period a pin may remain in an aneurismal sac without doing damage is perhaps dependent on the individual, and state of the aneurism, but it ought never to exceed forty-eight hours. It is questionable whether all the necessary advantages derivable from the irritation of the wall of the aneurism could not be produced within a few hours. . . . If the aneurism be very large, several pins may be introduced from several points, always allowing a considerable interval to exist between each, otherwise there might be too much damage to the vessel wall at one spot. . . . When the pin has been withdrawn, though there may be a little thickening of the tissues in the neighbourhood, there will probably be little or no diminution of the excentric impulse. Occasionally it may be weeks before any distinct or tangible thickening of the coats can be made out. In other instances this may be discernible at a much earlier period. But, as a rule, a distinct thickening of the coat is tangible at an early period."

It will be seen that the aim in Prof. Macewen's use of acupuncture differs somewhat from that of other surgeons, in that his object is to irritate the wall of the aneurism, the irritation being carried just so far as to set up reparative exudation in the parietes, infiltration of these with leucocytes, and then a further separation of these from the blood current. This irritation is set up at as many points as possible, so as to produce numerous white thrombi, and so complete occlusion as soon as possible. Of the four cases given by Prof. Macewen, three are of especial interest in their bearing on the treatment of aneurism now under discussion.

No. 1 was a case of aortic aneurism seen at an advanced period when threatened by impending death from dyspnoea. It was treated by the introduction of pins, the first early in Dec. 1887, this being repeated on seven occasions, with a few days' interval between each. On Dec. 20, dyspnoea reappeared, and returning Dec. 31, proved fatal. At the autopsy two-thirds of the aneurism was filled with a white, firm, laminated thrombus; had the deposition continued at the same rate it is clear that complete occlusion would have occurred in a few weeks.

Another case was an aneurism of the abdominal aorta, treated by the same formation of white thrombi; the cure was interrupted by the patient feeling so well that he determined to return to work (engine driving) after a month's treatment, though the aneurism was not consolidated. This patient was still alive and in seeming good health when last heard of two and a half years subsequently.

The third case, which is given in great detail, is the most interesting of all. The aneurism was here in the thoracic area, probably of the left subclavian, and accompanied by great swelling, pain, numbness and loss of power in the left arm.

Pins were introduced Feb. 27, March 3, 17, and 24, a gradual thickening of the walls ensuing, and made evident by the greater difficulty experienced in penetrating the coats of the aneurism, a pin of very fine calibre being used at the onset, some much stouter and more rigid being required later on. During the next four months there was much diminution in the swelling and pain. Pins were again used on five subsequent occasions, but as in two of them it was doubtful if any cavity was entered, their use was discontinued. During the following months there was slow but continuous decrease in the swelling, and the oedema and pain gradually disappeared entirely, the patient being finally able to resume all her ordinary duties.*

It would appear from the above report that an anæsthetic was not needed in any of the above cases, a point of great importance in thoracic aneurism where dyspnœa and atheroma may be present.

Prof. Macewen has kindly sent me, July 1895, the following abstract of his most recent experience :

"I have had three cases of aneurism treated since I wrote my paper. One at root of neck, subclavian, but involving aorta. Cure absolute. One aortic, transverse arch, greatly thickened and improved. Patient can go freely about and follow his usual avocation from which he was debarred prior to operation. One, a very large popliteal, in which consolidation took place rapidly, but owing to the great pressure exercised by the aneurism on the surrounding parts, which was apparently increased by the consolidation, incision had to be made into the sac. Firm laminated white thrombi were found inside the sac, part of which was turned out to relieve the pressure and to preserve the vitality of the limb. The patient made a rapid recovery and is now quite well, the remainder of the white thrombus becoming converted into dense fibrous tissue, which subsequently has undergone great shrinking.

"Quite a number of very advanced aortic and abdominal aneurisms have been seen by me—so advanced as to preclude interference. In several an exploratory puncture was made for diagnostic purposes, when the eroded bodies of the vertebræ were felt bare inside the aneurismal sac. These were not treated.

"I have heard of cases which were so advanced that 'they burst before the pins which had been sent for to treat them with had arrived.'"

III. GALVANO-PUNCTURE.—This method has for its object the production of clotting without the risks and difficulties connected with the introduction of foreign bodies. Like the latter, it has scarcely had a fair trial, being too often not made use of till the size attained by the aneurism forbids any hope of cure, and almost of relief.

Points to pay attention to.—(1) To avoid production of heat, pain, and sloughing of the skin, the current† used should be a

* Another very successful case, under the care of Caselli, of innominate aneurism treated by Macewen's method, will be found briefly given in the *Revue le Chir.*, 1892, p. 892, and two unsuccessful cases, *Glasgow Med. Journ.*, 1891, pp. 280, 453. Prof. Macewen pointed out (*Ibid.*, p. 454), that this method required cases to be carefully selected, and that it was not to be used in those which could not get well otherwise.

† Dr. McCall Anderson, in a most successful case (*Lancet*, 1873, vol. i. p. 261), employed four to six cells of a Stöhrer's battery. In a case of Dr. Ords (*Lancet*, 1880, vol. ii. p. 450), followed by temporary benefit, six to eighteen cells of a Foveaux's battery were used. Dr. Bastian (*Brit. Med. Journ.*, 1873, vol. ii. p. 595) made use of five to eleven cells of the same battery.

comparatively weak one. As an anæsthetic is not usually required the time occupied may be considerable. (2) The needles should be of steel, as fine as is consistent with perforating the tissues, in order to diminish pain, hæmorrhage, and risk of sloughing. (3) To avoid the same risks, the needles should be insulated with about $\frac{1}{2}$ inch of their points by two layers of spirit varnish. (4) As it has been proved that the effect of electrolysis on blood at the positive pole is a fairly firm and tenacious dark clot, while the negative rather produces a pinkish, frothy substance, it seems wiser to connect the needle or needles introduced into the sac with the positive pole, while a large sponge wrung out of warm salt-water is connected with the negative pole and applied to the chest wall near the swelling. (5) A sitting should not be prolonged over thirty or forty minutes. The punctures had best be closed by collodion. (6) The operation should not be repeated too soon, time being allowed for all local reaction to cease and for consolidation of the coagulum to occur, which often takes some time.

Drawbacks and Dangers.—(1) As pointed out by Mr. Holmes, "it is a radical defect of this method that it acts by inducing 'passive' coagulation of blood in the sac. Hence, it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In fact, the cases are few in which a perfectly happy result has been obtained, but some of these are worthy of particular attention.

Amongst these is a case of Cinisellis (Holmes, *loc. supra cit.*), in which an aneurism of the ascending aorta, quickly increasing, pushing out the third and fourth ribs, with powerful pulsation, rapidly diminished with much solidification after galvano-puncture for forty minutes, the patient resuming his work as a coachman ten weeks later. In Dr. McCall Anderson's case the aneurism was a small one, about $3\frac{1}{2}$ inches in diameter; after galvano-puncture on three occasions the swelling was only about one quarter of its previous size, and for the most part very solid. In a case of Dr. Carter's (*Lancet*, 1878, vol. ii. p. 761), an aneurism of the thoracic aorta appearing in the right sub-clavicular region, and accompanied by much pain, was treated by galvano-puncture on three occasions with very great relief, the pulsation becoming almost imperceptible and the pain disappearing.

Dr. Stewart, of Philadelphia, (*Am. Journ. Med. Soc.*, vol. ii. 1892, p. 426) advises the use of electrolysis in combination with the introduction of wire. He claims that with the combined method a smaller and safer amount of wire can be used, and that, "instead of a soft unstable coagulum about the wire, tardy in appearing, there may be produced almost immediately a tough clot, which, in favourable cases, should tend by accretion to produce prompt obliteration of the sac cavity." Out of eight cases collected two were successful.

In deciding between the introduction of foreign bodies (*e.g.*

wire) and the use of galvano-puncture, I think that the use of Maclewen's needles (p. 541) deserves a further trial.

It is clear, however, that, if anything like prolonged relief is to be given, any operation must be resorted to at an earlier date than has hitherto been the case. Where rapid increase and thinning of the coverings of a large sac are present, together with a wide communicating opening, and where diffuse aneurismal changes outweigh the amount of sacculation present, the surgeon who declines to interfere will do wisely. And I would again draw attention to the remarks at p. 534 (a point to which attention has not been sufficiently directed), that surgical interference may, in cases of large aneurisms, do more harm than good by diverting the blood current from the original aneurism into some outlying and unsuspected secondary sac, and thus cause dangerous and, it may be, fatal pressure on important parts which have hitherto escaped. Besides this danger, three others have to be remembered when wire is introduced. (1) Embolism. (2) Suppuration of the sac. Both these have been made much rarer by carefully rendering the wire aseptic. Any inflammation of the sac should at once be treated by ice-bags. (3) Introduction of the wire, &c., beyond the aneurism (foot-note, p. 540).

PART III.

OPERATIONS ON THE THORAX.

CHAPTER I.

REMOVAL OF THE BREAST (Figs. 139 to 143).

Indications.—The following remarks must be considered to refer to that most common and important of diseases—carcinoma.

This is an operation which deserves more careful study than it usually receives, on the following grounds—viz., the frequency and the distressing nature of the results of cancer here, and the fact that, while the operation is still a stigma on our profession, there is reason to hope that it is, yearly, becoming more successful. The first two of the above points need only to be stated. When I speak of the operation of removal of the breast for carcinoma being still a stigma upon our profession on account of the bad results, I do so advisedly. I am aware that in many ways we are not to blame. Women will always be unwilling to make known their fears here, on account of a natural delicacy; but another reason leads them to conceal the earlier stages of a growth (in which alone it can be thoroughly dealt with), and that is the well-known want of success which, hitherto, has accompanied operation. Surgeons are also not to blame for the fact that precious time is often lost by the medical attendant when he is consulted, in some cases from a mistaken kindness and desire to make light of fears, in others from a disbelief in the value of operation here.* While

* The imperfect operations of the surgery of pre-antiseptic days gave much ground for this belief. Thus, Sir James Paget spoke of recurrence after operation as being "as certain as anything in surgery." Halstead, of Baltimore, writes (*Ann. of Surg.*, Nov. 1894, p. 504): "The younger Gross did not save one case in his first 100. Dr. Hayes Agnew stated in a lecture, a very short time before his death, that he operated on breast cancers solely for the moral effect on the patient; that he believed the operation shortened rather than prolonged life. H. B. Sands once said to me that he could not boast of having cured more than a single case, and in this case a microscopical examination had not been made." On the other hand, Halstead gradually improving on German surgeons who have

in cancer of the sexual organs we shall always have to deal with late cases, surgeons should help to secure better results in the case of the bosom by operating more widely and completely when dealing with malignant disease here. It is only when we have put it in the power of the general practitioner, who is consulted first, to say that he knows of cases still alive several years after the operation, that patients will take a more confident view of the operation here and seek surgical relief earlier.

To ensure such improved results the following conditions are essential:

A. To operate much more widely and thoroughly than is yet the rule, and thus to endeavour to remove every atom of tissue which recent researches have shown may be the seat of disease. This will include not only removal of the whole breast, and clearing out the axilla always, but the taking away also in every case part of the pectoralis major, to ensure removal of its sheath (*vide infra*), and in cases which come to the surgeon in the second stage, or in which the progress has been rapid, more extensive steps still, after the method of Halstead (p. 561).

B. To exercise as far as possible a careful and judicious selection of cases.

C. To keep patients under supervision for a long time, and, at first, to see them at short intervals.

A. The operation to be much more wide and thorough than is yet the rule, in order to remove every atom of tissue which may be diseased.

Advocating as I do most strongly, for reasons given above, the habitual performance of operations for cancer on the widest possible scale consistent with the patient's safety, I would draw attention to the following practical points bearing on the breast and the way in which cancer attacks it which have been brought into prominence lately. (i.) The breast is, in reality, a much more extensive organ than is usually believed. In addition to the well-known prominence, there is often a ring of outlying gland-masses of varying size and extent. Mr. H. J. Stiles, in a most helpful paper (*Ed. Med. Journ.*, June and July, 1892), thus alludes to the latter point. "The breast tissue is not encapsulated into a compact body, but is so broken up and branched at its periphery that the stroma becomes directly continuous with the superficial fascia. There is, therefore, no capsule in the ordinary sense of the term." (ii.) The ligamenta suspensoria may contain breast-tissue and lymphatics. Both these facts make clear the futility and risk of niggardly skin incisions. (iii.) There are often lobules of breast tissue intimately connected with the pectoral fascia. These are certainly left behind if the breast is merely separated from the pectoral fascia, as often done. (iv.) A deep

worked so earnestly at this problem, claims out of fifty cases operated on by his complete method in the years between 1889 and 1894, to have only had 6 per cent of local recurrences.

lymphatic plexus or lymph path runs in this fascia from the breast towards the axilla. Volkmann was the first to teach prominently that it was right to remove entirely the pectoral fascia. Prof. Halstead thus quotes from Volkmann's *Beiträge zur Chirurgie*: "I was led to adopt this procedure because, on microscopical examination, I repeatedly found, where I had not expected it, that the fascia was already carcinomatous, whereas the muscle was certainly not involved. In such cases a thick layer of apparently healthy fat separated the carcinoma from the pectoral muscle, and yet the cancerous growth, in places demonstrable only with the microscope, had shot its roots along the fibrous septa down between the fat lobules, and had reached and spread itself out in flat islands in the fascia. It seems to me, therefore, that the fascia serves, for a time, as a barrier, and is able to bring to a halt the spreading growth of the carcinoma."

The above points in the structure of the bosom, which explain how easily outlying and deeply placed deposits of cancer may escape niggardly and superficial operations, will explain many of the steps enjoined below in the account of removal of the breast.

Question of the Need of Removal of the Whole Breast, and of Clearing out the Axilla in Every Case of Cancer.—It will be gathered from the above account that I here follow, and would advise others to follow, Mr. Banks, whose views on this matter have been so clearly and vigorously put forward.*

It is only right to remind my readers that these views have been criticised with much ability by Mr. Butlin (*Oper. Surg. of Mal. Dis.*, p. 357 *et seq.*). While I am well aware of the weight that is due to his opinion, the following are my reasons for differing from him:—

Mr. Banks holds most strongly that in every case of cancer of the breast—(I.) The whole breast, the skin over it, the fascia over the pectoral muscle, and (if at all suspicious) the fibres of this muscle should be removed. (II.) The axilla should be cleaned out whether any enlarged glands can be felt or no.

Mr. Butlin (*loc. supra cit.*, p. 376) considers that (I.) the practice of removing the whole breast is "theoretically and practically wrong," and again (p. 375), he believes this wholesale method of treating cancer of the breast "to be unscientific and needlessly cruel to many women." Amongst his reasons, put forward with much ability and carefulness, for preferring a more partial operation are—

1. With regard to **recurrence**. "Certainly, in the vast majority of instances, there is nothing to lead one to believe that the new growth arises in the outlying lobules of the mammary gland, or in any remains of the parenchyma of the gland." If this

* *Brit. Med. Journ.*, 1882, vol. ii. p. 1138; address before the Harveian Society (*ibid.*, 1887, vol. i.); *Liverp. Med. Chir. Journ.*, 1883.

view be correct, it must be allowed that extensive operations with a view of removing all the breast are needless, and deserve Mr. Butlin's condemnation quoted above. But with our ignorance as to how exactly cancer recurs in the breast, can it be said to be correct? I venture, with all respect, to hold a totally different opinion on this most cardinal point. I hold with Dr. Creighton (*Contrib. to the Physiol. and Pathol. of the Breast*), that, in the great majority of cases, cancer here is a disease of a breast becoming obsolete, or actually so; that one result of this is that the atrophying acini become so disordered as to allow their epithelium to escape into, and infect, the surrounding connective tissue. Though the exact way in which this disbandment of the epithelium is started is unknown, it is a most important step, the connective tissue of people after middle life being unable to resist the encroachments of epithelium, as we see in the lip and penis. It is this which not only may start a carcinoma, but which makes it so difficult to prevent its recurrence, unless by early and complete operations, because the connective tissue goes widely beyond the breast.

Mr. Stiles, *loc. supra cit.*, believes that "local recurrence of carcinoma after removal of the breast is usually due, not to the rest of the breast being in a pre-cancerous state, but to the non-removal of small and often microscopic foci of cancer, more or less remote from the main tumour, and depending for their origin upon the arrest and growth of cancerous emboli disseminated more or less directly from the primary tumour along the lymphatics.* The importance of removing all the retro-mammary tissue, pectoral and axillary fascia, axillary fat and glands, along with the breast in all cases of carcinoma, cannot be too thoroughly insisted upon or too often repeated. The anastomosis and intersection of the lymphatics are so free that it is impossible to say towards which set of glands the lymph from any given point in the breast will be conveyed. I have seen cancerous lymphatic emboli at the axillary border of the mamma when the tumour was situated in the inner hemisphere and *vice versa*."

The following cases, from an important paper by Mr. Raymond Johnson, read before the Pathological Society (*Brit. Med. Journ.*, 1892, vol. i. p. 70) illustrate, I contend, the accuracy of the opinion which I have given above, that it is most unsafe to leave any portion of a breast the seat of malignant disease.

In a case of infiltrating carcinoma in a woman, aged twenty-seven, microscopical examination of parts of the breast, which appeared normal to the naked eye, revealed masses of cancer cells apparently lying in lymphatic spaces. In another specimen of the infiltrating variety, the microscopical varieties strongly suggested that widespread carcinomatous change was involving the whole organ.

* Mr. Stiles's observations lead him to recognise five sets of lymphatics in the bosom; (1) a cutaneous set including those of the nipple-areola, and surrounding skin; (2) sub-areolar; (3) intra-mammary; (4) in the circum-mammary fat; (5) retro-mammary.

sections showing the new growth arranging itself around the small ducts which were themselves normal. In the case of a woman, aged thirty-four, a small nodular carcinoma was situated at the axillary border of the left breast. After removal two small nodules were found at the sternal end of the gland, each having the typical structure of glandular carcinoma, whilst microscopical examination of the central part of the breast showed marked proliferative changes in the epithelium of the acini, these changes probably standing in the same relation to cancer of the breast as chronic superficial glossitis does to cancer of the tongue, namely, a possible pre-cancerous condition.

Heidenhain, in a most valuable paper ("Ueber die Ursachen der lokalen Krebsrecidive nach amputatio Mammæ," *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, Berlin, 1889), teaches that in breast cancer there are proliferative changes in the lobules throughout the whole gland, which must be looked upon as the direct forerunner of cancer ("das mittelbare Vorstadium der Krebsentwicklung"), and which sooner or later pass into cancer.

On this account, believing that whether the whole breast is, in the great majority of cases, in a condition to become carcinomatous or not, that partial operations are liable (especially when the coarse fat, which is often so abundant, and the hæmorrhage in the operations are remembered) to leave behind potential foci of disease, I consider that more wholesale operations are, in these days of modern surgery, the reverse of "unscientific and needlessly cruel to many women."*

* Sir Spencer Wells, "Morton Lecture on Cancer and Cancerous Diseases" (*Brit. Med. Journ.*, 1888, vol. ii. p. 1204), advised removal of the entire breast save in a certain class of case where growths are found at the axillary border of one or both breasts. These growths may be neither of the breast nor of the axilla, but dependent upon peculiar sweat glands met with in this region. Mr. Marshall in his Morton Lecture (*Lancet*, 1889, vol. ii. p. 1048) also advocates thorough measures. "Do not care about a scar, but sweep away to a great distance; follow the tissues up specially towards the axilla, especially when the tumour is on the axillary side of the mammary gland." Finally, to quote one surgeon only on the other side of the Atlantic. Prof. Dennis, "Recurrence of Carcinoma of the Mamma" (*Trans. Amer. Surg. Assoc.*, 1891), writes: "The uniform classical operation should include the entire breast gland, all the fatty areolar connective tissue in the vicinity, the integuments over the circumscribed area of the tumour, and as much more as is necessary, *leaving out of consideration altogether the question of flaps to cover the wound*,† and, finally, the pectoral fascia." In order to afford the surgeon an additional means of ascertaining the limits of the breast and of the disease, Mr. Stiles (*loc. supra cit.*) recommends the use of nitric acid which, rendering the parenchyma of the gland and carcinomatous tissue dull greyish white and opaque, causes the smallest specks of both to stand out from the fat and connective tissue in which they are embedded, the fat remaining unaltered and the connective tissue becoming translucent and somewhat gelatinous. Immediately after removal the breast is placed (after washing off all the blood) in from 1 to 2 pints of a 5 p.c. nitric-acid solution for about ten minutes, and then washed in running water for three or four minutes. This examination can be completed before the wound is sutured.

† The italics are mine.

2. With regard to the **severity**. There can be no doubt that the more extensive operations are the more severe. I doubt, however, very strongly whether, at the present day, with earlier operations, a wise selection and preparation of cases, with the antiseptic precautions at our command, aided by subsequent skin-grafting, the mortality will be largely increased. If there must be an increase, the gravity of the disease for which the risk is run, and the object that is in view, must not be forgotten.

3. **The mutilation.** All will agree with Mr. Butlin when he writes, p. 382, "I believe it affects women much more than we, and even they, perhaps, are inclined to admit, and it is not improbably one amongst several causes which lead them to conceal the presence of a tumour of the breast until long after the period at which it may hopefully be removed." While this is a matter which must be sorrowfully remembered, and its explanation weighed with due reverence when a surgeon is inclined to blame his patient for having concealed her disease, I think that another and more potent reason usually leads women to defer the operation until the setting in of the second stage and the commencement of pain, and that is, the widespread knowledge of the frequency of cancer here, and the failure of operations to exterminate the disease.* If only we could show better results—and, though not a believer in any extensive curing of cancer, I believe that we can do so by combining earlier operations, a wise selection of cases, going very wide of the disease, and paying strict attention to antiseptics throughout—women would, I think, come forward more readily for treatment with that calm good sense in which, in addition to quiet patience, they too often surpass us.

(II.) **That the axilla should be cleared out in every case.**—I advocate this for two reasons: (a) While I am aware that in some exceptional cases the glands are never implicated at all, while the disease recurs inveterately in the scar made for the removal of the breast, I believe strongly that, in the great majority of cases, to clear out the axilla is the wiser course, for if the surgeon wait, as Mr. Butlin (p. 383) advises, till the glands are obviously enlarged, or till there is fulness not amounting to actual proof of enlargement, he will often wait till it is too late—*i.e.*, till not only the glands, but the connective tissue and fat of the axilla, are implicated as well, and till the supra-clavicular glands have had time to become infected, though not visibly enlarged. (b) I do not consider, with the surgery of the present day, that opening up the axilla adds to the severity of the operation. If good drainage and those antiseptic precautions which have been so often mentioned are duly attended to, the axillary wound heals rapidly.

* General practitioners who see these cases in the first instance might render valuable aid here. Too many are inclined to palliate from a mistaken kindness in "hoping for the best," and many from an unbelief in the curability of cancer.

Question of the need of severer operations still, such as Halstead's, involving removal of the whole thickness of the pectoralis major, and often of the minor also.

It will be seen, when the operation recommended by Prof. Halstead and that advised by myself are compared, that while I advocate much freer incisions than are usually made, great attention to getting away every atom of breast tissue, removal of the surface of the costo-sternal part of the pectoralis major and its fascia which lie subjacent to the breast, and, in every case also, opening the axilla and getting out, in one piece, all the fat which lies between the anterior and posterior boundaries quite up to the axillary vessels, I would only remove the whole thickness of the pectoralis major when I could feel enlarged glands between it and the minor, or high up in the apex of the axilla, or where the case came to me with the second stage much advanced, and that I have not yet, save in two cases, divided the pectoralis minor. Prof. Halstead, on the other hand, removes the whole thickness of the costo-sternal part of the great pectoral, and divides the minor also, in order to remove the fatty connective tissue and any glands which lie in it along the axillary vessels. While the performance of such extensive operations is certainly in the right direction, and, coming with the recommendation of Prof. Halstead, is worthy of every attention, I should, for my part, reserve them for cases in which I met the conditions mentioned above; and it must be remembered that even after such extensive operations, there is still danger that the lymphatic tract, running up behind the clavicle between the highest glands in the axilla and the lowest in the supra-clavicular region, will have become involved, though a year or more may elapse after the patient is lost sight of before the supra-clavicular glands show any sign of enlarging, owing to the way in which malignant deposits will sometimes remain latent and quiescent for many months. Again, if these severer operations are adopted as a rule, the mortality will certainly be raised. Lastly, if the whole thickness of the costo-sternal part of the pectoralis major is removed and the pectoralis minor also, it will be much more difficult, in a wound so deep and so irregular, to keep in place the large grafts which I have recommended to be made use of, after Thiersch's method (p. 560).

I may add that, while this sheet is passing through the press, it has happened that four cases in which I have removed the bosom for cancer have come under my observation.

In three, three years had elapsed, and in one of them the lady has just been operated on for cancer of the other breast. In the fourth, five years and ten months* have passed since the operation. In none is there the slightest sign of recurrence on the side operated on, and in the case in which both bosoms have

* In this case the carcinoma was a large mass, though still mobile, and many infiltrated axillary glands were removed. Before the patient was sent to me by Dr. Climson Greenwood, of St. John's Wood, she had been to one of the Hospitals for Women. She was there told that her case was unfit for operation, and that she should try for admission into a hospital for incurable cases.

become the seat of cancer and have been removed, the cancer in the second case appeared near the nipple, and could in no way have been due to an extension from an imperfect operation on the opposite side, which, moreover, remains sound.

I in no way look upon the above as *cures*. Owing to the way in which minute deposits of cancer at times remain temporarily latent and quiescent, a fact which I have again alluded to here and in my remarks on epithelioma of the tongue, I hold that at least six years must have elapsed since the operation before the word *cure* can be used.

B. A careful and judicious selection of cases.

I. *Cases to which an Operation is altogether unsuited, or especially doubtful and (in many) dangerous.*—(1) The very aged—*e.g.*, after sixty; not only are the aged less healthy, but they are less troubled by the cancer, and more resigned. (2) The unhealthily fat* and plethoric. (3) Habitual over-eaters. (4) Tipplers on the sly. (5) The subjects of a confirmed bronchitis, and weak heart. (6) Subjects of decided albuminuria, cirrhosis, or diabetes. (7) Extensive disease of the skin, accompanied by scattered tubercles or œdema, and, worst of all, a brawny, leather-like, greasy condition of the skin, with firm œdema and open sebaceous glands, approaching the condition of cancer *en cuirasse*. (8) Quick growth, with rapidly increasing fixity.† (9) Supra-clavicular disease.‡ (10) A young patient, especially with a voluminous breast,§ a rapidly increasing growth, and a bad family history.

* Sir James Paget, from whom many of the above have been taken, thus writes (*Clin. Lects. and Essays*, p. 14): "The over-fat are certainly a bad class, especially when their fatness is not hereditary, but may be referred in any degree to their over-eating, soaking, indolence, and defective excretions. The worst of this class are such as have soft, loose, flabby, and yellow fat, and I think you may know them by their bellies being pendulous and more prominent than even their thick subcutaneous fat accounts for, for this shape tells of thick omental fat and, I suppose, of defective portal circulation." Some earlier remarks of Sir James may here be quoted: "Such people must be carefully managed; not fed too well; not kept too long in bed; not allowed to retain their refuse; and mere bigness must not be taken for plethora."

† There are no worse cases for operation than those in which malignant disease supervenes on mammary abscess and induration in suckling women.

‡ If other points are favourable, and if it seems justifiable on account of pain, threatening ulceration, &c., to give the patient temporary relief by the removal of the breast, enlargement of glands here need not deter the surgeon; when the disease has been removed below from the breast and the axilla, the supra-clavicular glands will, I believe, be found to enlarge slowly, and as the space which contains them is large, they do not become adherent quickly. I have twice within the last four years operated in cases, in which these glands were slightly involved. In one the patient lived three years, in the other fourteen months, after the operation.

§ The more vascular the breast, and the more abundant the fat, the more difficult will it be to make certain of extirpating not only the growth, but also every atom of the breast. Speaking of vascularity, I have been asked if removal of the breast is justifiable in hæmophilia. A case recorded by Mr. Macnamara (*Lancet*,

(11) Of course, the presence of carcinoma elsewhere—*e.g.*, uterus—or secondary deposits. That operation is not absolutely contraindicated where both breasts are involved is shown by a case of M Page's (*Brit. Med. Journ.*, 1888, vol. ii. p. 937 :

Here both breasts were the seat of carcinoma, and both were simultaneously operated on by Mr. Page and Mr. Silcock. The patient, aged sixty-eight, made good recovery. Notes are also given of another interesting case, in which a large carcinomatous breast was successfully removed, an axillary gland being also removed, in a woman aged seventy-four.

II. *Cases in which an Operation is indicated.*—(1) Cases somewhat advanced in life, for the younger the patient the more active is the cancer. (2) Especially if patients who are on in years are thin and dry and tough, clear-voiced and bright-eyed, with good pulses and digestion, and no cough or wheezing. (3) Small breasts and little fat. (4) Where the growth is circumscribed with distinct outline. The worst defined tumours are the worst for recurrence. (5) Where the growth is very hard. The "stoniest" growths are usually the slowest. (6) Skin not involved. (7) Absence of fixity. (8) Either no axillary glands, or but very few, involved. (9) Rate of progress slow, and family history good.

III. *Cases in which an Operation is doubtful.*—These lie intermediate between I. and II., both as to the general and local points.

Operation (Figs. 139-143).—The chief objects to be borne in mind throughout the operation are :

1. **To get away every atom of the disease, and, as far as possible, in one piece.**—The main difficulties in securing this are : (a) The fact that while cancer may be actually declared in the tumour only, yet the whole breast is in a pre-cancerous condition (p. 550), and one on which cancer may easily supervene if an atom of the gland is left behind. (b) Owing to the amount of fat which is often present, it is very difficult to make sure that every particle of gland tissue has been removed, especially when the parts are obscured with blood. (c) The breast is a more diffuse and extensive organ than is usually taught (p. 547).

2. **To remove entirely the lymphatic tract between the breast and the axilla** (Fig. 143).

3. **To clear out the axilla.**—This should be done, as a regular thing, in every case of cancer of the breast, whether any glands can be felt or no.

* The parts having been well cleansed, including the axilla, and

1884, vol. i. p. 294) perhaps bears on this. The patient here had had epistaxis, from which four relatives had died. There was no history of bleeding from wounds. The breast was removed with a loss of blood "certainly not greater than is usual in such cases." I doubt if this is a case of hæmophilia. My experience of operations in hæmophilia is unfavourable.

* Important points in the preliminary treatment are regulating the patient's diet, getting rid of her refuse, and treating any bronchitis, however slight this may appear to be. Sir W. Savory (*Brit. Med. Journ.*, 1883, vol. ii. p. 167) gives two cases which show that pregnancy of three and seven months is no bar to serious operations on the breast.

this space shaved, and an aseptic compress put on securely for some hours before; the patient's neck and abdomen are well protected with mackintoshes, with warm towels beneath, while towels wrung out of carbolic-acid lotion (1 in 20) are securely packed around the area of the operation. The arm is then carried away from the side and an elliptical incision is made from a point close to the sternum, passing along the lower border of the breast, and then somewhat upwards towards the axilla. An assistant standing opposite to the surgeon now draws up the breast, while the surgeon, taking the edge of the cut skin with his left finger and thumb, dissects this off in a downward direction till he is well below the lower limit of the breast, getting quickly down to the level of the muscles. Spencer Wells' forceps being applied to any spouting vessels, an assistant makes sponge-pressure on this flap, and draws the breast somewhat down, while the surgeon makes another elliptical incision starting from the same point as the first, but passing upwards along the upper limit of the breast (Fig. 139) and then descending somewhat to meet its fellow just below the tendon of insertion of the pectoralis major.* While the breast is drawn downwards by the assistant who is making pressure on the lower flap to prevent bleeding, the surgeon raises an upper flap in the same way as the lower, taking care to get above the upper limit of the breast, and in either case keeping the point of the knife towards the skin, and not towards the breast, but not sufficiently so to make "button holes."

Opportunity may be taken here to refer to these elliptical incisions, and the flaps which are raised thereby. I am strongly of opinion that the way in which they are often planned and carried out is not only futile, but highly perilous. What is far too often done, is, by means of such elliptical incisions, to include the nipple and a very slight margin of skin on either side. The breast is then quickly removed without any due precaution as to getting above and below its limits; the wound comes, without any trouble, excellently together; nothing could look better at the time, but in a few months the disease inevitably reappears locally. I am certain that we should do much better in these days of anti-septic surgery and skin-grafting if we reverted to the ancient method of deliberately sweeping away the whole breast and all the skin over it. The elliptical incisions should be carried very wide of the nipple, close to the lower and upper limits of the breast,† and the flaps should be reflected well beyond the breast

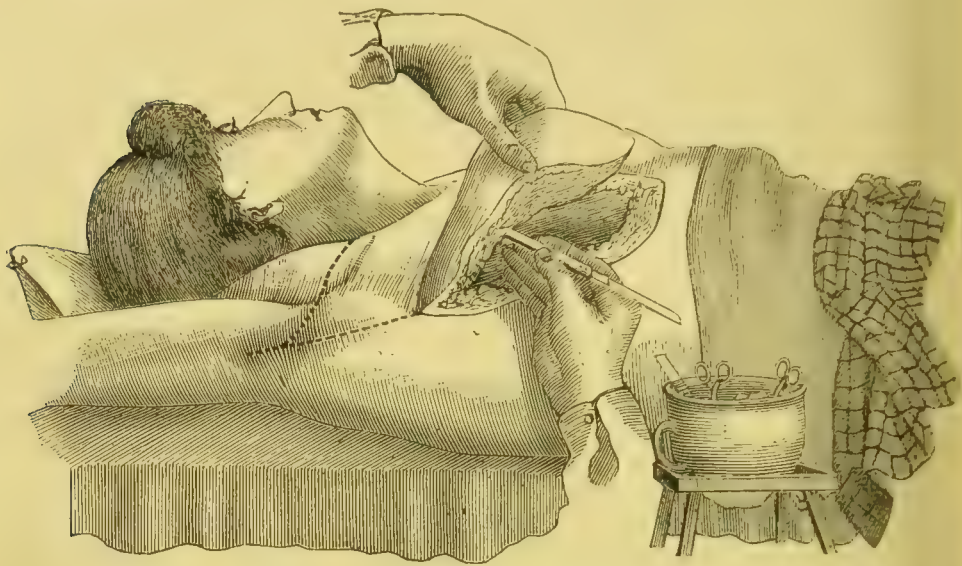
* A not uncommon mistake in marking out the flaps is to go very far on one side, and then dangerously near on the other.

† Mr. Stiles advises (*loc. supra cit.*) on this point that the lower margin of the ellipse should reach well down below the costal margin close to the ensiform cartilage, its upper end terminating at the outer border of the pectoralis major opposite the third rib. An incision from the outer end of the ellipse, a little below the great pectoral to the angle between the lower edge of its insertion and the biceps, will open up the axilla. This prolongation should be made at the

limits. No skin that is even doubtful should be hesitated over for a moment. All the skin over that half of the breast, at least, in which the cancer is, had better go. It may be answered to this that there will be a wound left, gaping more or less widely. This objection can be met, to a large extent, by following the steps detailed below. But if a gaping wound has, after all, to be left, while it does not look so well at the time, it can be covered with grafts after Thiersch's method (p. 569), and will give a far better result afterwards.

The incisions having been made as directed, widely separated

FIG. 139.



I would ask my readers to remember that I insert this plate only to enforce the need of *free* incisions. Further, they will remember that the operation does not cease with the removal of the breast. This is only being stripped from the pectoralis major in order to facilitate further steps.

from each other, the flaps cleared off till the limits of the breast above and below and at the sternal and axillary ends are clearly defined, all bleeding points secured, the surgeon proceeds to strip off the breast from the pectoralis major with his fingers and scalpel. I advise this step now, as it exposes the pectoralis fascia and muscle, and facilitates their free removal. The bosom should, unless very unwieldy, be kept continuous with the axillary fat and glands while these are cleared out, so that breast, lymphatic tract, glands and axillary fat, which may easily conceal small glands, may be removed in one continuous piece (Fig. 143). The next step is to remove the costo-sternal part of the pectoralis major. This should be done in every case. It causes no

same time as the other incisions, as it allows of the flaps being dissected up with sufficient freedom. The ellipse thus marked out should measure at least four inches across at its widest point—*i.e.*, the nipple. The dissection of the lower flap should be carried as low down as the seventh rib in the mid-axillary line. The upper one should be reflected inwards beyond the edge of the tumour, and upwards almost to the clavicle.

really troublesome bleeding, and as recent researches have shown (p. 547) that a deep set of breast lobules and a plexus of lymphatics lie in the fascia over the muscle, it is never safe to leave this fascia, as it is quite impossible to tell with the unaided eye whether it is involved or no. Any attempt to remove the fascia from the muscle is to be condemned as certain to leave some of the fascia behind, while from the oozing which attends any such attempt, more blood is lost than when the muscle itself is removed. An incision is made vertically through the attachment of the muscle a little outside the sternum, the clavicular and costo-sternal parts are then quickly separated by a finger working in the interval between the two parts, and finally by cutting through the humeral attachment of the muscle just internal to the spot where the fibres begin to fold in at their insertion. One or two perforating arteries will bleed freely, but they can be easily taken up with Spencer Wells' forceps curved on the flat. The large wound is now covered over with lint wrung out of hot bichloride solution (1 in 4000), when the next step, the clearing all the fat and glands out of the axilla, is proceeded with.

It is most essential that this step should be undertaken in every case, that it should be done with the utmost thoroughness, and that, as far as possible, the fat and lymphatics should be removed in one piece. With a pair of blunt-pointed scissors the fat in the armpit is cleared out over the serratus magnus up to the posterior fold of the axilla, the subscapular nerves being spared if possible, while the intercosto-humeral are sacrificed. The fat often varies with the patient, being of a tougher character in the thinner, and looser, more readily breaking down, almost liquefying, in stouter patients. It should always, as far as possible, be removed in one piece, right up to the axillary vessels, as by this step two most important points are secured: (a) the removal of the whole lymphatic tract between the breast and the axillary vessels; (β) if the fat and glands are pulled out piece-meal or in bunches, there is much risk that some of the lymphatic glands very small, though already infiltrated, will be left behind. Another but less important reason for removing all the fat is that it is a poorly vitalised structure, and prone to suppurate tediously if the healing do not follow a typically aseptic course.

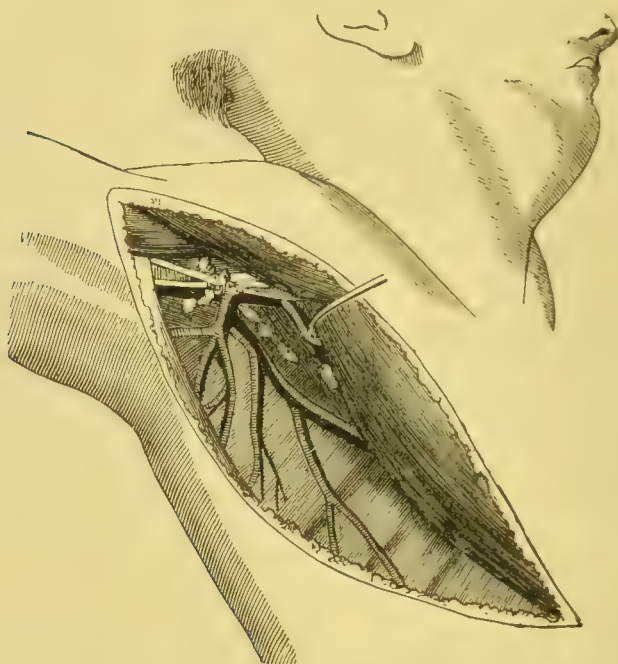
During the clearing out the axillary fat and lymphatics, the scissors are used chiefly to cut with, as the fat is detached over the serratus magnus, and from the posterior border of the axilla; they are also very useful, as the top of the axilla is reached, when used closed as a blunt dissector, or in fashioning a pedicle whenever a vessel has to be clamped with Spencer Wells' forceps.

The breast being removed, any remaining bleeding points should be secured, and it may be here said, once for all, that, in removal of a breast, vessels will be met with chiefly at the four following points: (1) In the cut edges of skin; (2) coming through the pectoralis major; (3) at the outer edge of the pectoralis major, coming through the serratus magnus; (4) at

the axillary end of the incision, branches from the external mammary and subscapular, this latter being usually the largest of all.

Every precaution must be taken not to rupture the axillary vein, an accident best avoided by remembering its position, by using no sharp instrument, and working without any undue tearing or force. The large sub-scapular vein nearly always requires ligature, and if this, or any other branch, is torn away close to the axillary vein, an accident which here, as in branches of the internal jugular, is not at all unlikely to happen if undue

FIG. 140.



This plate is inserted to remind my readers of the existence of lymphatic glands between the pectoral muscles. (After Sédillot.)

force is used, or if the parts are made adherent by growth, most embarrassing hæmorrhage will take place. This is only to be met by taking up the aperture with a ligature around it, if this be feasible, or by ligaturing the vein above and below. In some cases it is not till the surgeon has reached the very top of the axilla, that he finds, his operation being well-nigh completed, that there are still glands so adherent to the vein and adjacent parts that they cannot be removed, and that his operation must be an incomplete one.

When the axilla seems to be thoroughly cleared out, attention must still be paid to the apex, and the space between the two pectorals.

In any case in which there is even a suspicion that the second stage has been reached, as shown by any skin-dimpling, in all cases in which the progress has been rapid, the pectoralis minor should be severed and the axillary vessels and the apex of the axilla

examined up to the first rib, whether glands can be felt or no. The fatty tissue which lies along the vessels and in which lymphatic glands may be found should be carefully cleared away, as far as possible, in one piece. During this, and all other stages of this extensive operation, the axilla must be kept filled with sponges and the rest of the wound covered with lint, wrung out of hot bichloride solution (1 in 4000).

To reach enlarged glands in either of these two latter situations, both pectorals must be divided near their insertions, completely if necessary. Such a step will cause additional hæmorrhage, probably from the long thoracic and muscular branches, and will call for thorough drainage and greater attention still to keeping the wound sweet. It is, however, far better to face these than to run the risks, inevitable otherwise, of leaving mischief behind which the surgeon will never again have so favourable a chance of attacking, or of doing harm to the large vessels, by working in the dark.

If at any stage of cleaning out the axilla the axillary vein is so embedded in the malignant deposit that this cannot be removed without taking away a part of the vein also, this may be done without hesitation, two chromic-gut ligatures being first applied.*

The wound is now thoroughly sponged out, all hæmorrhage finally arrested, and any needful drainage provided for.

Where the bleeding has been thoroughly arrested, and where a wound, kept aseptic throughout, is left dry at the last, and the gaping chasm which remains after a complete operation obliterated and afforded firm support by careful bandaging, no drainage will be needful.† In his earlier cases any surgeon will be on the safe side who drains the axilla by a tube one end of which is brought out at the axillary end of the wound, the other by counter-puncture, posteriorly.

The wound having been most scrupulously dried, and a little iodoform or Jeyes' powder dusted on it, the surgeon sees how far he will be able to close the wound. And without describing an easy case, I would say at once that it is often possible, by paying attention to the following details, when the arm is brought down, to unite a wound perhaps completely, in which any attempt to close the edges appears at first quite hopeless, as in cases where 5 or 6 inches separate the edges. To begin with, a very large number of sutures should be used, upwards of twenty-four perhaps in a widely gaping wound, so that the tension shall be distributed as evenly as possible over a large number instead of falling heavily upon a few: Thus about eighteen or more sutures of stout carbolised silk or

* In two cases in which I was compelled to remove a portion of the axillary vein between two ligatures, the resulting œdema and trouble were much less than I expected; in one case they could scarcely be said to occur at all.

† If the above conditions are not fulfilled, if, owing to oozing continuing, discharges collect, severe tension and perhaps sloughing will take place in the part of the wound that has been closed, while burrowing may take place along the ribs as far back as the angle of the scapula.

wire (the latter having the advantage of being rapidly twisted up, are passed some distance from the edges of the flaps near where these join the chest. This gives the sutures a firm hold, and also obliterates the extensive wound. These sutures being tightened up, the edges of the wound are brought into exact apposition with numerous salmon-gut sutures. The surgeon when unable to unite the wound completely, must rest content with bringing the edges of the flaps as near as may be, thinking only of extirpating the disease thoroughly, and not of the look of the wound. The stout sutures should be cut at the time of the first dressing. All of them should not be divided too early, and with regard to these and other sutures, it is not necessary to disturb the wound by *removing* the sutures. Judicious *cutting* of those on which the tension is too great is all that is required at first. Owing to the great elasticity of the skin, aided by a little morphia, I find very little pain follows a wound which is at first extremely tense.

The part of the wound that cannot be closed should then be covered with large skin-grafts taken after the method of Thiersch. The region of the shoulders having been carefully cleansed, the surgeon with extremely keen razors cuts very thin shavings consisting of the epidermis and the extreme tops of the papillæ (as shown by the part from which the graft is taken just oozing from a number of minute points some seconds after the razor is used). These grafts should be at least 2 inches long by at least an inch: they should be cut with a very light sawing movement of the steel, and should gradually rise up on to the back of the razor in delicate folds. Wetting the skin and the razor in very dilute carbolic-acid lotion will facilitate the use of the instrument. When each graft is cut it should be at once carried on the razor close to the surface of the wound, where it is partly floated off, partly drawn off, by an assistant with two needles and carefully flattened out *in situ*. The periphery of the wound should first be covered, then the centre. In a large wound both shoulders will have to be requisitioned. By some surgeons it is recommended to take the grafts from the thighs, but there is an obvious objection to this course in the case of women both at the time and later: furthermore if they are taken from the shoulders and arms the temporary smarting entailed is merged in that of the wound, while one set of bandages does for all. Wherever these large grafts are employed, care must be taken to cut them, as above directed, as thin as possible. A quickly oozing surface shows that the razor has been dipped to a needless depth, while, worse still, any fatty tissue on the under surface of the graft means a wound which will be sensitive, long in healing, and leave a scar rich in memories which might easily have been prevented. Another mode of taking large grafts is to dissect up, *e.g.*, from the inner aspect of the arm a large parallelogram of skin, remove the superfluous fat from its under aspect and then place it, suitably divided, on the surface of the wound. The edges of the skin around the area from which it has been taken are then united

with sutures. This method, if the wound heals by primary union—a result not always obtained in a patient just submitted to a severe operation—has the advantage of leaving one linear healing wound, and at first sight less scarring. But if the razor is keen, and if it is used with a light hand, the resulting scars are, in a few months, truly trifling.

The wound being finally cleansed, any drainage-tube syringed through to free it of clots, iodoform or Jeyes' powder is dusted into the axilla, and sufficient iodoform gauze wrung out of carbolic acid (1 in 20) and sal-alembroth wool are then applied. The dressings are kept *in situ* by bandaging round the abdomen and chest, and over the clavicle and point of the shoulder, the object being to distribute the discharges as evenly as possible, and to meet their tendency to come through at three spots—viz., at the lower border of the dressings, at the sternal end of the wound, and behind the axilla. It is well, before the arm and forearm are shut in, to dust on a little zinc-and-starch powder over the elbow and palm, especially when the weather is hot and the skin delicate, owing to the irritation of the perspiration which is thus shut in.

I prefer to keep my patients as much propped up as possible, and turned on to the sound side, thus facilitating drainage from, and early closing of the axillary end of the wound where cellular tissue has been much opened up. If feasible, they should sit up with a bed-rest on the second day, and be got out of bed as soon as possible.

Out of respect to Prof. Halstead and the excellent work which he has done in many directions at the Johns Hopkins University, Baltimore, I here quote, in his own words, the account of his mode of removal of the breast (*Ann. of Surgery*, November, 1894). I will state a little later, when my readers have had an opportunity of making themselves acquainted with his method, the points in which it appears to me to be open to criticism.

"(1) The skin incisions are carried at once and everywhere through the fat. (2) The triangular flap of skin (Fig. 141) is reflected to its base. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major, where it is continuous with the fat of the axilla. (3) The costal insertions of the pectoralis major (M, Fig. 142) are severed, and the splitting of the muscle, usually between its clavicular and costal portions, is begun and continued to a point about opposite to the scalenus tubercle on the clavicle.* (4) At this point the clavicular portion of the pectoralis major and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla. (5) The loose tissue under the clavicular portion (the portion usually left behind) of the pectoralis major is carefully dissected from this muscle as the latter is drawn upwards by a broad, sharp extractor. This tissue is rich in lymphatics, and is sometimes infiltrated with cancer. (6) The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment. (7) The whole mass, skin, breast, areolar tissue and fat, circumscribed by the original skin incision, is raised up with some force, to put the submuscular

* (?) First rib.

fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor. It is well to include the actual sheath of the minor muscle when practicable. (8) The lower outer border of the minor muscle having

FIG. 141.

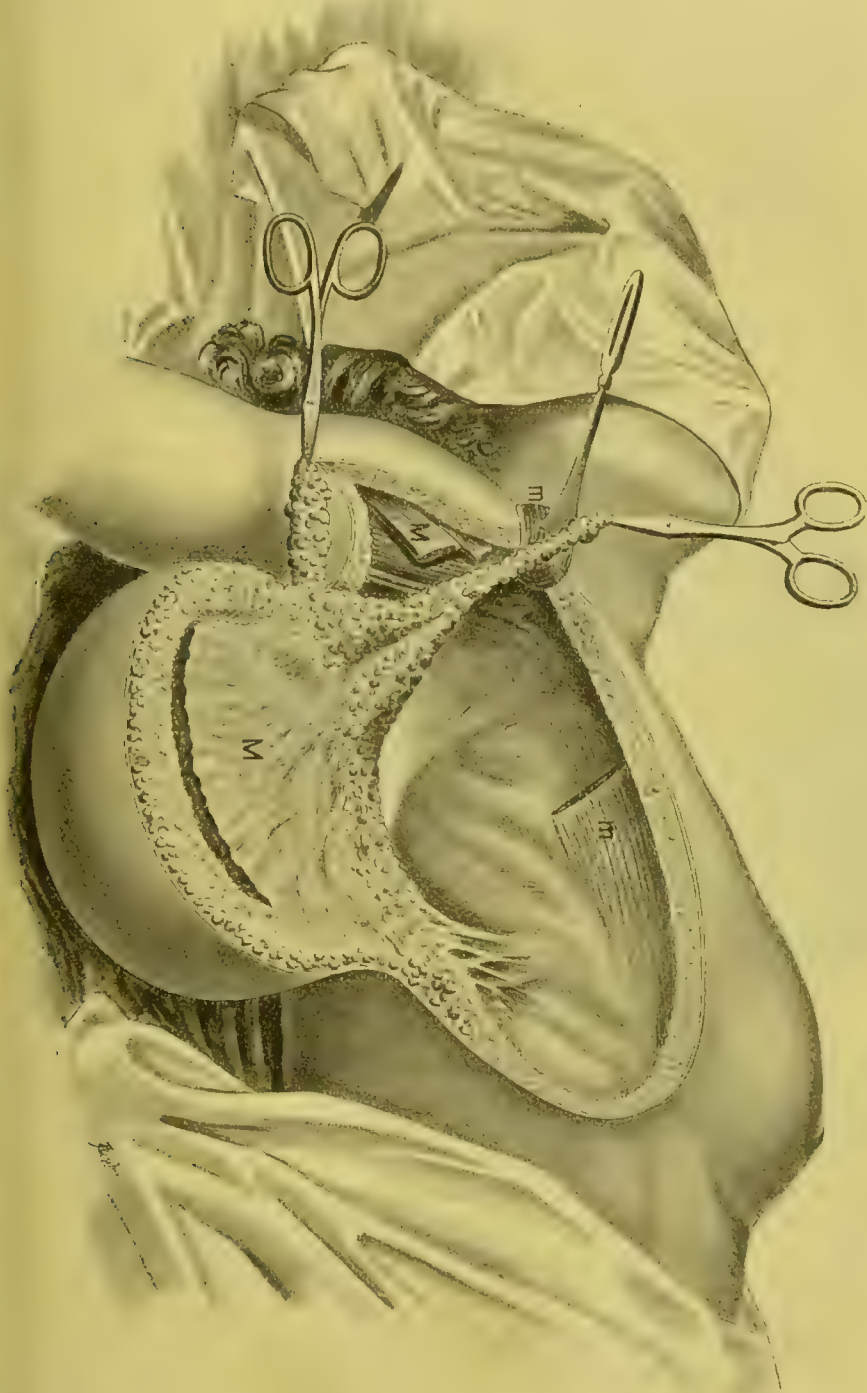


(Halstead.)

been passed and clearly exposed, this muscle is divided at right angles to its fibres and a little below its middle. (9) The tissue, more or less rich in lymphatics, and often cancerous over the minor muscle near its coracoid in-

section, is divided as far out as possible, and then reflected inwardly to liberate or prepare for the reflection upwards of this part of the minor.
 (10) The upper, outer portion of the minor is drawn upwards (Fig. 142)

FIG. 142.

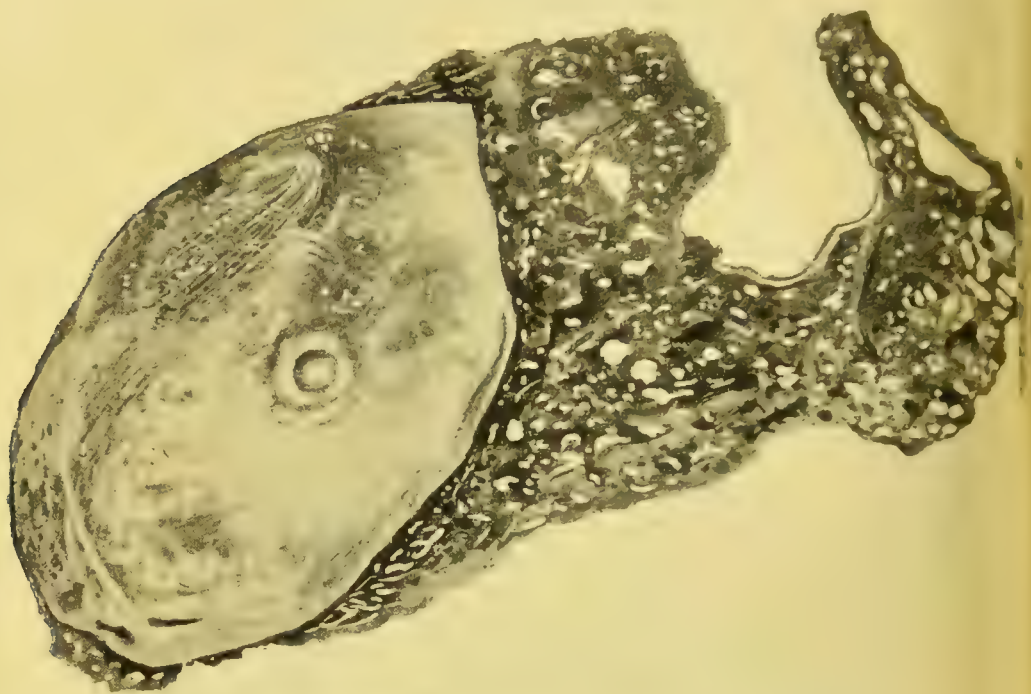


(Halstead.)

with a broad, sharp retractor. This liberates the retractor, which until now has been holding back the clavicular portion of the pectoralis major. (11) The small blood-vessels (chiefly veins) under the minor muscle near its insertion

must be separated from the muscle with the greatest care. These are embedded in loose connective tissue which seems to be rich in lymphatics, and contains more or less fat. This fat is often infiltrated with cancer. These blood-vessels should be dissected out very clean, and immediately ligated close to the axillary vein. The ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off, or the vessels themselves might be torn away by the clamps. Furthermore, the clamps, so many of them if left on the veins, would be in the way of the operator. (12) Having exposed the subclavian vein at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers as advised, I am sorry to say, in modern text-books and as practised very

FIG. 143.



This shows the continuous whole or single piece, breast, axillary fat and glands, of which the part removed should consist. (Halstead.)

often by operators. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed, it is best to push the vein away from the tissues rather than, holding the vein, to push the tissues away from it. It may not always be necessary to expose the artery, but I think that it is well to do this. For sometimes, not usually, the tissues above the large vessels are infiltrated, and we should not trust our eyes and fingers to decide this point. It is best to err on the safe side and to remove in all cases the loose tissue above the vessels and above the axillary plexus of nerves. (13) Having cleansed the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla. We must grasp the mass to be removed firmly with the left hand, and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus. (14) When we have reached the junction of the posterior and lateral

walls of the axilla, an assistant takes hold of the triangular flap of skin and draws it outwards to assist in spreading out the tissues which lie on the subscapularis, teres major and latissimus dorsi. The operator, having taken a different hold of the tumour, cleans, from within outward, the posterior wall of the axilla. Proceeding in this way we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed, at the discretion of the operator. Küster lays great stress upon the importance of these nerves for the subsequent usefulness of the arm: we have not as yet decided this point to our entire satisfaction, but think they may be often spared to the patient with safety. (15) Having passed these nerves, the operator has only to turn the mass back in its normal position, and to sever its connection with the body of the patient by a stroke of the knife. All that has been removed is in one piece (Figs. 142 and 143). There are no small pieces nor shreds of tissue. I believe that we should never cut through cancerous tissues when operating, if it is possible to avoid doing so. The wound might become infected with cancer, either by the knife which has passed through diseased tissue, and perhaps causing everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli, or from the lymphatics. The division of one lymphatic vessel, and the liberation of one cell may be enough to start a new cancer. . . . The operation, as we perform it, is literally an almost bloodless one. From the first to the last each bleeding point is stopped with an artery forceps as quickly as possible. When practicable, the vessels are clamped before they are divided. . . . The edges of the wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin, only the base is included in this suture. The rest of this flap is used as a lining for the fornix of the axilla. The apex of this flap is consequently shifted to a new and lower position. The axilla is never drained and invariably heals by first intention. The uncovered wound often heals by the so-called organisation of the bloodclot."

The results of this operation are most encouraging. Of 76 operations, 50 complete and 26 incomplete, not one death resulted from the operation. The disability produced by the operation is stated to have been slight and due to the cicatrix, not to division of the muscle. As to later results, Prof. Halstead claims that he has only had 6 per cent. of local recurrences.

C. Long continued supervision repeated at first at short intervals.—The patient should be kept under skilled supervision, and for the first few years an inspection of the scar should be made every three or four months. Any local recurrence in or near the scar should at once be attacked widely and deeply, resection of one or more ribs being performed, if needful, as in the case to which I have alluded at p. 577.

Questions which the Surgeon may be asked, or which he may have to put to himself.

1. *How long will my patient live if I do not operate?* This can only be answered approximately by considering the *average* duration of life, from the earliest discovery, in cases of scirrhus. This is about two years and a half. The stage* which the growth has reached must be carefully considered.

* Mr. Sibley (*Med. Chir. Trans.*, vol. xlii.) gives thirty-two months; Mr. M. Baker (*ibid.*, vol. xliii.) gives forty-three months. Mr. Beck (*Dict. of Surg.*,

The following questions can only be provisionally answered. It is to be hoped that in another ten years, with wider extirpation carefully performed on a large scale, it will be possible to give much more favourable answers.

2. *How long will my patient live if I do operate?* It is still to be feared that if a really large number of cases were taken by different operators—this being an operation which nearly every one thinks himself competent to perform—the average date of recurrence would still be found to be an early one, certainly within the year. On the other hand, if the statistics of those surgeons alone who, having large operative experience, have dealt with cancer cases on increasingly wide lines, were taken, there would be increasing grounds for giving a more hopeful outlook. Cases are multiplying in frequency in which there has been no recurrence for three years, or even longer. And again, if such statistics as the above only were taken, there would be another distinct, though a minor gain, when the site of the reappearance was examined, it would be found much less frequently in and about the scar, and with increasing frequency in deeper parts, a form of reappearance for many reasons less distressing to the patient.

3. *What are the risks of the operation itself?* In other words what are the risks that the patient, instead of dying in one or two years of the disease, may die in one or two weeks of the operation? * In most cases, with careful after-treatment on modern lines, the risks are slight. The deaths from operation are mainly due—(a) to septic causes—*e.g.*, erysipelas, pyæmia, &c.; (b) to lung-trouble—*e.g.*, broncho-pneumonia; (c) to the anæsthetic in a patient the subject of old bronchitis.

My own impression is that very few surgeons who do not pick their cases with a view to their own successes, who publish the results fairly, and who operate largely on hospital cases, will obtain

vol. i. p. 185), apparently quoting from Prof. Gross, divides the course of an ordinary scirrhus of the breast, unrelieved by treatment, into these three stages: *First*, when the disease is limited to the breast, the duration of this first stage averaging fourteen months. *Secondly*, the stage of invasion of the skin and the axillary lymphatics, taking, in the average, from the fourteenth to the twentieth month. *Thirdly*, the stage of ulceration and general infection, usually taking from the twentieth to the twenty-seventh month to close the case in death. In atrophic scirrhus the average duration of cases not operated on is given as eighty-two months, patients having been known to survive fifteen or even twenty years. With encephaloid cancer the average duration is under a year. Even after removal of the breast it is said to be only sixteen months and a half.

* Sir James Paget and Mr. Erichsen gave 10 per cent.; Mr. Bryant, 6 per cent.; Dr. Stettegart, giving the statistics of operations performed from 1873 to 1876 in one of the hospitals at Berlin, gives a mortality of 7 per cent. where the breast alone was removed, and 23 per cent. where the breast was removed and the axilla cleared out as well (*Lang. Arch.*, Bd. xxiv. 1879). These statistics, nowadays, require revision: that last given, is, with the advantages of the present day, much too high. Thus, Mr. Butlin (*loc. supra cit.*, p. 370) considers that the mortality should not exceed 5 per cent.

a death-rate below at least 8 per cent. It is not septic causes which, nowadays, kill these patients, it is causes which, even when foreseen, no amount of care and caution will always prevent when an operation is forced upon us. I allude to bronchitis after an anæsthetic when the chest is hampered by bandages and the patient, scarcely answerable for her actions, persistently slips down in the bed, to the failing strength and vitality with which the flickering light of the life of a patient with a fatty heart or albuminuria is snuffed out, it may be two or three weeks after the operation. Severity of operations rarely brings about a fatal result, unless the patient prove unamenable, another condition against which it is extremely difficult to guard.

Fresh statistics, to be of any value, will be required of this operation, performed with modern completeness, and with strict aseptic precautions maintained throughout.

Reasons which may make a Patient wish for an Operation beyond gaining a mere Prolongation of Life.—These may be :
 (a) Relief from pain,* which otherwise increases daily ; the misery of waking every day to the consciousness of an incurable disease ; † the sometime loathsomeness ; the restlessness for cure (Paget).
 (b) The return of the disease in the scar is often less grievous than the original disease—*i.e.*, the induration, ulceration, excavation are slower and less marked than in the breast tissue. ‡ (c) Death by

* After the first year usually the pain becomes increasingly dull and heavy, then more and more lancinating ; finally, when the growth is ulcerating, a hot burning sensation is substituted for, or added to, the lancinating pain (Paget, *Surg. Path.*, pp. 646, 647). Thus, while the growth is small and can be removed with good hope, the patient refuses operation because she cannot believe in cancer without pain. Later on, when she seeks relief from her pain, all hope of a permanent cure has usually passed away.

† Sir C. Bell's vivid picture of the advanced stage of cancer of the breast may be quoted here. It should stir up in every mind an earnest desire to secure earlier operations. "The general condition of the patient is pitiable. Suffering much bodily, and everything most frightful present to the imagination, a continual hectic preys upon her, which is shown in increasing emaciation. The countenance is pale and anxious, with a slight leaden hue ; the features have become pinched, the lips and nostrils slightly livid ; the pulse is frequent ; the pains are severe. In the hard tumours the pain is stinging or sharp ; in the exposed surface it is burning and sore. Pains, like those of rheumatism, extend over the body, especially to the back and lower part of the spine ; the hips and shoulders are subject to these pains. Successively the glands of the axilla and those above the clavicle become diseased. Severe pains shoot down the arm of the affected side. It swells to an alarming degree and becomes immovable. At length there is nausea and weakness of digestion ; a tickling cough distresses her ; severe stitches strike through the side ; the pulse becomes rapid and fluttering, the surface cadaverous, the breathing anxious, and so she sinks" (*Med. Chir. Trans.*, vol. xii. p. 223).

‡ While this is correct, local recurrence, as being constantly visible to, and dwelt on by, the patient, is much to be deprecated. If only it was more the custom to operate very widely and deeply, and without attempting much primary union (p. 555), local recurrence would be almost unknown.

deposits in the viscera, these being unseen, is less distressing to the patient than death by the original cancer in the breast, which is always under her eyes. (*d*) The patient may have especial reasons for wishing to live and get about in comparative comfort for a year or so.*

Thomas's Method of removal of Innocent Mammary Tumours.—As fibro-adenomata are far from uncommon, and as any scar on the breast is much deprecated by young women, this operation which Dr. Gaillard Thomas, of New York, introduced in 1882 may be made use of when a patient especially deprecates a scar on the bosom itself. An incision is made exactly following the groove between the skin of the lower half of the breast and that of the chest. On reaching the muscles, the breast is dissected from them sufficiently to allow of its being turned upwards so as to expose its posterior aspect. A straight cut is then made through this over the tumour, and the latter removed. The gland is then replaced. Antiseptic precautions must be employed and adequate drainage provided. The scar is invisible save when a free incision has to be made—*e.g.*, for a fibro-adenoma high up in the breast; the ends of it then show.

Owing to the excellent results and very trivial ultimate disfigurement which the ordinary method of removing fibro-adenomata affords, that of Dr. Thomas will very rarely be called for.

* Thus, in a case mentioned by Sir B. Brodie (*Lect. on Path. and Surg.*, p. 202), he declined at first to operate on a lady with a scirrhus of the breast on the point of ulcerating. In a few weeks the patient returned, begging to have the breast removed, that, her life being rendered more comfortable and active, she might accompany in society an only daughter. The operation was successfully performed, and at the end of two years the patient died of secondary pleuritic effusion.

CHAPTER II.

PARACENTESIS AND INCISION OF THE CHEST. RESECTION OF RIBS.

PARACENTESIS AND INCISION OF THE CHEST.

INDICATIONS for interference in pleuritic effusions. Before interfering operatively, the surgeon has two points to consider. **Whether fluid is present.** II. **Whether it is purulent or not.** My space will only allow of my dealing with the second of these points.

II. **Is the fluid purulent or not?** The importance of clearing up this point is manifest from the fact that if pus is present it is very rarely absorbed; it may burst into the lung, may burrow about, making its way externally, causing hectic, caries, and lardaceous disease.

A. Exploratory puncture (*vide supra*). A large hypodermic syringe and needle should be used, absolutely clean, pervious, and the needle sufficiently long and not too flexible. The timely use of this may save a patient from being treated for weeks or longer for chronic pneumonia. A grooved needle should never be trusted to. It is readily plugged by a pellet of fat, and thick pus will not flow along it.

B. Presence of pyrexia and hectic. This is not always reliable. Fallacies: (a) They may be absent, or little marked, in empyema, especially in long-standing cases, the alteration of the pleura or the degree of tension preventing absorption. Occasionally the disease is latent for many months. (b) Well-marked pyrexia may be present in serous effusions; thus, in these, the evening temperature may reach 101° .*

C. The aspect of the patient. The tint is often anæmic and earthy in long-standing empyema, and the finger-ends, especially in children, clubbed.†

* In 1886 I tapped the chest of one of our students, under the care of Dr. Pyemith, whose temperature was 103° . The fluid was serous, and after the single aspiration a good recovery took place.

† "If a child be seen with general pallor and finger-clubbing, one ought to think of empyema rather than of the other causes of clubbing—viz., chronic bone disease, bronchiectasis, and congenital heart-disease" (Barlow).

D. Age. Empyema is common in children* and young adults.

E. Rigors. Those are often slight, irregular, and may occur only towards evening. In children they are often absent throughout.

F. Any preceding disease. Empyema is not unfrequent after pneumonia, scarlet fever, measles, childbirth, pyæmia, small-pox, and especially typhoid fever. The onset is most insidious and often overlooked. If a patient during convalescence seems to go back, loses his appetite, any embarrassment of the breathing must be at once looked for, and empyema suspected.

G. Œdema. This is often absent, though pus is present.

H. Other signs, especially in children, must be remembered—viz., unexplained and obstinate diarrhœa, emaciation, &c.

Treatment of Non-purulent Serous Effusions.—

Question of operation. If medical treatment—*e.g.*, absorbents and diuretics, counter-irritation, dry, nutritious diet, &c.—fail, two questions arise: A. *What is the danger of leaving the fluid?* B. *What is the risk of paracentesis?*

A. *Danger of leaving the fluid.*

1. There is the risk of sudden death when a large, quiet effusion persists.†

Dr. Moxon showed that the effect of the effusion varied with the side affected. Thus an effusion into the right chest not only pushes the heart over to the left, but also compresses the right auricle, and so shuts off blood from the heart, thus tending to produce syncope from cardiac anæmia. Effusion on this side also tends to make lateral pressure on the inferior vena cava, which is the more readily bent over, as it has just passed through a rigid ring. Effusion into the left chest drives the heart over to the right, and, pressing on the left auricle, distends the right side of the heart, by impeding the passage of the blood into the left ventricle, and thus tends to bring about syncope from cardiac plethora. There is also a tendency for the right lung to become œdematous and crepitant, owing to its being engorged with blood.

2. The lung may become more and more tied down by adhesions—*e.g.*, when much lymph has formed.

3. The sound lung may become engorged, especially if the patient is submitted to a chill.

4. There is the risk of slow pus-formation, especially in a patient much let down, where the effusion is secondary to some other disease, and where there is the history of a chill.

B. *The risks of paracentesis.*

1. Shock. This is especially probable in delicate patients with a nervous dread of the operation. 2. Syncope. A special cause of

* In children the pleura seems to have a tendency to form pus (Goodhart).

† I think it is Dr. Clifford Allbutt who records the case of a girl who had been brought to the Addenbrooke Hospital with a large, quiet, serous effusion. Having got out of the cart which had brought her, she was walking slowly across the green in front of the hospital, when, without a cry or a stagger, she was seen to fall dead.

this is perhaps alteration of the position of the heart and large vessels by removal of the supporting fluid. 3. Embolism from detachment of clots in the pulmonary veins. That this is a real risk is shown by a case of Sir B. Foster's, in which clots dislodged from the right pulmonary veins caused embolism of both renal and iliac arteries, with a fatal result from albuminuria, suppression of urine, and gangrene. Both 2 and 3 may perhaps be prevented by not drawing off all the fluid, and drawing it off slowly. 4. Edema of the lung. This is an undoubted danger. Shortly after the tapping (the effusion being usually a large one), urgent dyspnoea comes on with frothy, serous expectoration rich in albumen. Death usually takes place in about twenty-four hours. Dr. Duffin's explanation of this is probably the correct one. The compressed lung, after the removal of a large effusion, corresponds to a limb after the use of Esmarch's bandage—*i.e.*, the vaso-motor nerves are paralysed; thus, when the lung expands, sudden stress is thrown on toneless vessels, hence the transudation of sero-albuminous fluid, equivalent to the oozing so common after removal of the bandage.

Indications for Paracentesis in Non-purulent Effusions.

1. Threatened failure of the heart's action, shown by the failing pulse, the extremities growing cold, &c. 2. In all cases, and at any date, when the fluid is so copious as to compress the opposite lung. The base of this should be carefully watched, and any expectoration noted. 3. In all cases where, with a large effusion, there have been one or more attacks of orthopnoea. Relief will be most emphatically called for when, with this history, the patient lives some distance off, when he is no longer young and the chest no longer yielding, or when the opposite lung is at all oedematous. 4. In all cases in which a pleuritic effusion, occupying half one pleural cavity, has existed three or four weeks, and shows no sign of progressive absorption.

Paracentesis for Serous Effusions.—Site of puncture. This is decided by: (1) Physical signs. (2) The result of the exploring needle. Common sites are: (a) The sixth space in front of the posterior axillary fold, a spot which has the advantage of being thinly covered, and where the ribs are well apart. (b) In the seventh, eighth, and ninth space behind, in the scapular line. The eighth space is here very frequently used.

The patient being turned somewhat over on to his sound side, if he can bear this, and brought to the edge of the bed, or, if he must be raised, so supported that he can be readily lowered in case of faintness, the surgeon, having seen that the spot chosen for puncture is cleansed from any poultice débris, &c., and that his aspirator is thoroughly clean and in good working order, fixes his nail just above the lower rib, and holding the needle so that it cannot penetrate too deeply, plunges it straight into the pleural cavity, and brings his needle into connection with the vacuum. If the skin is very thick, and the needle slender, it is well just to

make a puncture with a scalpel's point. In either case it is the skin-wound which pains.

The following practical points should be remembered: (1) Not to catch the needle on a rib, a mistake which is easy when the ribs are close together. (2) To be sure and enter the chest cavity, a thickened pleura, or false membranes sometimes interfering with this. (3) Avoiding injury to the lung, by not plunging the needle in too deeply, or by guarding the point when it has entered. Usually the lung is at a considerable distance, but when the collection is a localised one, this accident may easily take place. (4) The fluid should not be drawn off too quickly or completely; if successive vacua are required, the later exhaustions should not be too complete. The patient should always be warned against making any sudden movement or a deep inspiration. If the flow stops suddenly, it may be due to a kink in the tube, or to a pellet of lymph plugging the needle. The flow should always be stopped at once—(a) if the patient faints, this being due sometimes merely to the withdrawal of a large amount of fluid, sometimes to the consequent displacement of viscera; (b) if any blood suddenly appears in the fluid, this coming usually from the rupture of vascular adhesions, more rarely from a wound of the lung; (c) if an irritating cough is set up, this being due sometimes to the unfolding of a temporary compressed lung.

When the needle is withdrawn, the puncture should be at once closed with collodion and iodoform.

If an anæsthetic is asked for, it may generally be safely given with attention to the precautions given below (p. 574). But, as a rule, the pain is so momentary that this is not needful. I have been disappointed with the results of injection of cocaine. With a nervous patient the spot may be numbed by a freezing mixture of ice and salt, or with the ether-spray. A little stimulant should be given before and after the operation.

EMPHYEMA.

The frequency of this in children* has been already alluded to.

At this time of life the prognosis is good, as the lungs are free from morbid changes. The formation of pus may be very rapid at this early stage of life, pus being present by the fourth, fifth, or seventh day. The importance of this is considerable. With pus lymph is present also, and thus—(a) the pleura is soon altered, thickened, and less prone to heal; (b) the lung becomes tied down; (c) the drainage-tube is readily blocked; (d) this lymph leads to subdivision of the cavity, and so to difficulty of thorough drainage and obliteration. All this shows the necessity of early and free incision.

Another important point is, that pus in the pleural cavity is

* Out of forty-four and sixteen consecutive cases of pleuritic effusion at Great Ormond Street, Dr. Barlow found twenty-seven and fourteen to be purulent.

frequently localised and encysted in children. This is not uncommon in the middle third of the thorax, the pus being limited above by adhesions, and below by the fixing of the lower lobe to the chest wall. Thus, at this spot loud bronchial breathing and modified resonance may be present. Finally, in children small multiple collections are not uncommon.

The surgeon will very likely be asked the question, whether the pus need be withdrawn, and if it will not be gradually absorbed. The chances of this are extremely small, and the risks of leaving it very great. They are—(a) external perforation, leading to the unfavourable results of insufficient drainage, caries, and amyloid disease. The most likely sites are—in front, above and below the nipple; antero-laterally, in the fifth space, just outside the rib cartilages. (b) Lung perforation, leading to gangrene and hectic. (c) Tuberculosis, if the belief is correct that an old empyema, even if caseated and inspissated, is still infective.

Treatment of Empyema.

A. Simple Puncture with Aspirator or Fine Trocar.—This is seldom curative. The liability of the cannula to become plugged, and, usually, the need of repetition, are serious objections. It is justifiable in a few conditions—(a) if the patient is very young or very timid; (b) if the collection is very small, or multiple; (c) if the patient is healthy, the pus sweet, and the refilling slow; (d) punctures may “coax pus to the surface” (Goodhart). Patients thus treated should be watched for some time. In a few cases preliminary aspiration is very useful—*e.g.*, in very large empyemata of sudden formation. Here a free incision may be followed by urgent dyspnoea from displacement of viscera.

B. Sub-aqueous Drainage.—This method, formerly much in use, is now rarely seen. One end of a long piece of india-rubber tubing is introduced, through a large cannula, into the chest, while the other end dips into some antiseptic solution. *Advantages:* (1) The method is simple and little painful. (2) The tube is usually well tolerated and (if secured) follows the movements of the patient. (3) The drainage can be made gradual and adapted to the expansion of the lung. (4) It is readily converted into a siphon for washing out the chest. I look upon this last as of very doubtful advantage, believing that, if the pus is fetid, a free opening should be made at once, and that washing out the chest is always risky, and meddlesome and uncalled for when the pus is sweet. The *disadvantages* are—(1) The tube, necessarily small, is easily blocked. (2) Ulceration soon takes place around the tube and thus air enters, or the tube slips out. It is allowable in children, or in very nervous patients, where the collection is neither great nor of long standing, and the lung will therefore be able to expand gradually.

C. Incision.—This is the method most frequently required, especially in adults, when the pus is thick and caseous, when it is fetid, and when it re-accumulates after aspiration quickly. The

advantages are, the free drainage which it gives, and the facilities for washing out the pleural cavity (if this is required). The *disadvantages* are, its severity in weakly patients and the tendency to close. The question will often arise whether a single or a double opening is required. A *single opening* is usually sufficient in children and in young adults, owing to the healthy condition of the parts, and the natural tendency to obliteration of the cavity. The sites usually chosen are the eighth or ninth space in the scapula line, or in the same spaces anterior to and below the scapula angle. I prefer the latter in adults, as the chief part of the opening is anterior to the latissimus dorsi, an incision through this muscle, in adults, having certainly the risk of causing oozing afterwards, which may be very serious in a weakly patient. A *double opening* is, very occasionally, required—*e.g.*, in very large cavities in adults, when the pus is fetid; when the case is of very long standing; when the ribs are very close together; when the pus is pointing high up and anteriorly, and thus the drainage is inadequate. The best instrument to cut upon in making the counter-operation is a stout silver probe. To this a drainage-tube can be attached by silk, and easily drawn into place.

The Chief Points of Importance in Incising an Empyema are the following: Amongst the first will arise the question of giving an anæsthetic. Speaking from an experience of 38 cases, in 34 of which an anæsthetic was given, I believe that an anæsthetic may be safely given in the vast majority of cases. On the whole, I think that chloroform is the most suitable, on account of the greater struggling (undesirable with viscera displaced), the dyspnœa from the mucus set up, and the subsequent bronchitis after ether, but I am certain that the way in which the anæsthetic is given is of more importance than the anæsthetic itself.

Of the 34 cases alluded to above, I have only known bad results follow the anæsthetic once—a case of large empyema with pyo-pneumothorax. The heart was displaced to the right side, the face and lips somewhat cyanotic, the extremities cold, and the pulse almost imperceptible. Although the dangers of an anæsthetic were put before him, the patient insisted on having one administered. On the whole, I thought ether the safest, because of the condition of the pulse. It was administered carefully, but caused coughing. The pus was thus sucked into a bronchus, up into the trachea, and thence drawn down to the opposite lung, causing death rapidly. Artificial respiration expelled, during expiration, pus from the trachea. As this patient was almost moribund before the operation, I now much regret the giving of an anæsthetic. It would doubtless have been wiser to have refused one, and to have trusted to minimising the shock by exhibiting a stimulant, and by a rapid operation.

A year later I was asked by my old friend, Dr. Goodhart, to operate on a somewhat similar case. This patient was also young, and there was here, too, a communication with the lung, the pus being, in this case also, fetid, but the pulse was good and there was no cyanosis. Chloroform being given, the empyema was incised by Dr. Nicholson, now of Gainsborough, then clinical assistant, under my supervision. The anæsthetic in this case was taken well, the discharge quickly became sweet with iodoform dressings frequently renewed, and the patient made a rapid recovery.

The injection of cocaine is worth a trial, but, as I have stated above, it has disappointed me. While an anæsthetic is only really necessary where two openings have to be made, or where a rib is to be resected, yet its administration in capable hands is usually so safe that I always make use of it.

The patient being supported over the edge of the bed or table, partly rolled over on to the sound side, or, if this is impracticable, being suitably propped up, the surgeon, having cleansed the part, fixes a finger-nail just on the upper margin of the lower rib in the space chosen, and makes an incision down to the muscles for $1\frac{1}{2}$ to 2 inches, just above his nail. This incision having exposed the muscles, a steel director is driven through into the chest wall, care being taken not to plunge it too deeply.* A pair of dressing-forceps is then run along the director and opened widely both horizontally and vertically. Owing to the gush of pus which is now violently expelled, it is well to throw a piece of lint, out of carbolic solution (1 in 20), over the wound, while the pus is escaping.† The opening is next thoroughly dilated by means of a pair of lithotomy forceps, or sequestrum forceps, the jaws of which are carefully separated, and the size of the cavity, the proximity of the lung, and the degree of granulation-formation all investigated. A large-sized drainage tube, with a few holes cut at its distal end is then inserted, and carefully secured *in situ*. One of the simplest, and at the same time, an entirely efficient plan, is to pass two loops of silk through the outer end of the tube with a needle, knot these loops, and then place in them bundles of gauze strips. After a few days a smaller size, of the shape (on a large scale) of a tracheotomy tube, may be worn.

Hæmorrhage during the operation is usually slight, and gives no anxiety afterwards. If any point give trouble, resisting ligature, after picking up the tissues with Spencer Wells' forceps, a pair of these left on for twelve hours will meet the case: a bit of a rib quickly resected will give access to a wounded intercostal

* If the chest is being opened low down, and the above warning not remembered, the director or the dressing-forceps, which follows it, may easily be sent into the peritoneal cavity.

† Occasionally, if the patient struggles, air is drawn into the pleural cavity after the escape of the pus, and then is expelled into the connective tissue of the wound, constituting emphysema. This will all pass off spontaneously. I have very recently met with a case of much more marked emphysema under the following conditions: Being asked by my colleague, Dr. Pitt, to incise the chest of a child who, after lobar pneumonia of the right lung, had rapidly developed empyema on the same side, I noticed that, after an incision at the angle of the scapula, the usual violent outgush of pus—itself free from blood—was immediately followed by frothy blood and a markedly emphysematous condition of the wound. I believe that here the lung-tissue, damaged by previous inflammation, had given way when the pressure of the fluid upon it was removed. A few days later it was evident that the lung had become adherent around the incision, which communicated freely with an opening in it, and that the emphysema had subsided. The case did well.

artery. The importance of not cutting through a thick muscle like the latissimus dorsi has already been alluded to (p. 574).

The opening must be sufficient, and, if there is any doubt about this, a part of a rib should be resected without hesitation, especially where these are very close together, or where the pus is foul (*vide infra*, p. 578).

If the question of washing out the cavity arise, probably from the discharge being foul, it should be remembered that this proceeding, however gently done, has, occasionally, brought about grave and even fatal results very suddenly. Whether these have been due to absorption, reflex nervous disturbance, or to dislodgement of thrombi, is uncertain, but it is beyond question that in several cases symptoms of impending collapse, and even death have followed on washing out an empyema, and that, too, in a patient who is well on in convalescence. Again, it cannot be too strongly insisted upon that foetor calls for a freer opening not for washing out. If, however, it is decided to make use of injections, dilute and bland ones—*e.g.*, Condyl's fluid—should be used, and these should be gently run in with a funnel and tubing and not thrown in with a syringe. A long period of drainage is often needed in adults, while in children the tubes can be quickly shortened. In both sufficient tubing should be retained to keep the opening patent, as long as any discharge remains.

During the prolonged after-treatment everything should be done to improve the general health. Change of air is here a cardinal point; first, getting the patient from his room, then outside the house, and, lastly, if possible, to the seaside.*

A point of no small importance in the after-treatment, especially in young subjects with flexible spines, is to encourage early systematic, deep breathing, and gymnastic exercises, and thus to promote expansion of the chest, and so to minimise that sequelæ of empyema, irremediable lateral curvature.

Before leaving the subject of the operative treatment of empyema, a few words should be said about the dressing of these cases. This should be strictly antiseptic from first to last—in cleansing the parts incised, disinfection of instruments, taking care that the pus escapes under an antiseptic atmosphere (p. 575), sufficiently free opening, adequate drainage, abundant dry, aseptic gauze dressings, changed twice perhaps in the first twenty-four hours, and then daily for the first week. Later on, when the patient is going to the seaside, he can easily be instructed to

* "Last, and most important of all—unfortunately for hospital patients treatment that cannot often be utilised—comes *Margate air*. Any seaside air is beneficial, but, weather and season permitting, I do not believe there is an corner of England so quickly restorative to children with empyema as that in which Margate and Broadstairs are situated; and, personally, I set more store by a change of this kind after the first three or four weeks have passed than in any continuation of antiseptic dressings" (Goodhart, *Dis. of Children*, p. 345).

remove and cleanse daily the short piece of drainage-tube which keeps the external opening patent, and to apply over the sinus a dressing of boracic acid lint and carbolised tow, with a dusting of iodoform, or Jeyes' powder.

Where an empyema exists on each side the wisest course is to open and drain one and, at the same time, to aspirate the other, which should be opened a few days later.

At the wish of Dr. Pye Smith, in a patient of his, a boy of nine, Mr. Manning, his house physician, adopted this course, with my assistance, in June 1895, with an excellent result.

Complications of Empyema and Reasons for Cases not Doing Well.

(1) Persistent septic condition, in spite of two openings, free drainage, &c. (2) Tubercular disease. (3) Lung mischief on the opposite side—*e.g.*, broncho-pneumonia, bronchitis. This is especially dangerous in patients over forty. (4) Long duration of the case, a free incision being deferred, or aspiration dallied with. (5) Caries of the ribs. Multiple spontaneous openings, with burrowing sinuses beneath the skin. (6) Age. From the feebler powers of repair, and the more rigid condition of the chest as life advances.

In July 1894, I opened an empyema in a patient of sixty, a patient of Dr. Herbert Burton's, of Blackheath, and Dr. Goodhart's, the patient making a slow but complete recovery.

(7) Cardiac dilatation. (8) Inflammation of other serous membranes. (9) Size of the empyema. The smaller and the more localised the collection, the better the prognosis. (10) Collection of pus forming in the opposite pleura. (11) A broken-down constitution. Intemperance. Kidney disease. (12) Mr. Godlee (*Dict. of Surg.*, vol. i. p. 459) reminds us that a curious complication of septic cases—*viz.*, cerebral abscess—has been noticed in a sufficient number of instances to make it unwise to overlook the possible association of one with the other. Judging from Dr. Fagge's remarks on thoracic disease as a cause of cerebral abscess (*Prin. and Pract. of Med.*, vol. i. p. 546), it would appear that disease of the lung itself is oftener the primary lesion upon which the abscess of the brain depends.

RESECTION OF RIBS.

Indications.—These are chiefly:

- A. Caries of ribs.
- B. In certain cases of empyema.
- C. For a wound of an intercostal artery.
- D. For removal of growths.

Apart from cases of tubercular origin, I have resected parts of the fourth, fifth, and sixth ribs, keeping up persistent mammary sinuses, the caries being here due to old abscess of the breast. In another patient I twice resected ribs in operations for extirpation of recurrent cancer of the left breast. Strict anti-

septic precautions can alone justify this, as the sal-alembroth dressings were placed in immediate contact with the lung and pericardium. The patient remained without further recurrence, two years after the resection of the ribs, and eight after the primary operation. A little later I heard that she had died, under the care of a homeopath, I imagine from another recurrence, or from visceral deposits.

A. In obstinate *caries*, where more than one rib is affected, where previous treatment, including gouging, fails, resection should be at once performed. It is a very simple operation in these cases, as the soft tissues are nearly healthy and the periosteum is retained.

An incision, about 2 inches long, being made over the centre of the carious rib, and the muscles peeled off with a blunt dissector, the periosteum is next incised, and separated from the upper and under aspect with an elevator, blunt and slightly curved, so as to pass readily under the rib and lever it upwards. The rib being thus raised, it is easily divided at one limit of its exposed part, either with a narrow-bladed saw or with slightly curved cutting-forceps. The soft parts are next peeled away from the under aspect, and the rib divided at the corresponding spot and removed.

B. In certain cases of *empyema*—*e.g.*, (1) when the drainage is insufficient, the discharge foul, in spite of one or two free openings; (2) when the ribs are too close together, for a tube of sufficient size; (3) when an empyema cavity still persists, though sweet, in spite of free incision, good drainage, and careful dressing. In the first two classes of cases removal of a small piece of one or two ribs will be sufficient, but in some of these latter cases the operation will necessarily be a much more severe one. When called to a case of persistent sinus and discharge after the incision of an empyema, the surgeon on examination may find that the cavity which remains is small, and that the discharge is due to a persistent sinus only. This should be dilated up with laminaria tents, part of a rib removed, and both sinus and cavity thoroughly scraped out with sharp spoons.

But in the majority of cases of long-standing empyemata the condition of things is not so simple and so easily dealt with. Obliteration has taken place often very imperfectly, owing to the lung not being able to expand, to the ribs having fallen in all they can, to the diaphragm having risen, and the opposite lung, the heart, &c., having come over as far as they are able, while the cavity, often large, which thus remains, is lined with much thickened scar-like tissue, covered with granulations of but poor vitality. Here portions of several ribs must be removed and the operation perhaps repeated, in order that the walls of the cavity may still further collapse, and thus obliterate the cavity while an opportunity is given for exploring this thoroughly.

The spot chosen for the resection of the ribs should be, as far as possible, opposite to the lung which can expand no more, and

the pieces of ribs removed should correspond as closely as may be to the anterior and posterior limits of the cavity which it is desired to close. The size of the cavity should be carefully estimated with the aid of sterilised catheters and sounds.

It has been thought by some that the amount of rib to be removed should correspond pretty closely to the distance between the two pleuræ. Thus it may be needful, especially in an adult, to remove pieces of five or six ribs, $3\frac{1}{2}$ inches being removed from some and 1 to $1\frac{1}{2}$ inch from others.

Dr. Fenger, of Chicago (*Med. News*, November 13, 1882), finds first the shape and extent of the cavity. He considers that a cavity which extends transversely requires resection of a large piece of one or of a few ribs, the largest piece taken being that from the rib which overlies the centre of the cavity. A vertical cavity covered by five or six ribs will need resection of small pieces of several ribs, from $\frac{4}{5}$ to $2\frac{1}{5}$ inches of bone being removed.

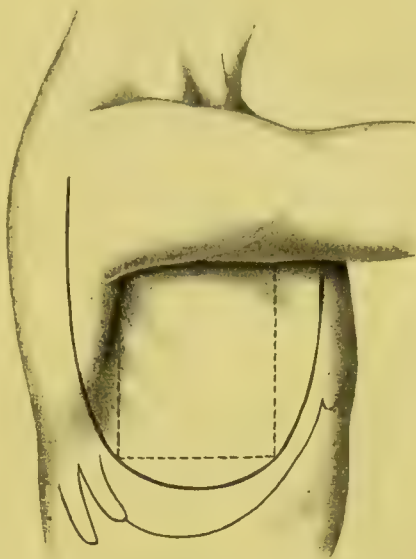
The ribs to be resected may be exposed in one of two ways. One is to make two or three incisions, and to raise flaps comparatively small in size. The other is to raise a single large flap, containing any muscles—*e.g.*, the pectoralis major and serratus magnus—which overlie the ribs to be removed.

This latter plan has the high authority of Mr. Godlee, who has done much to introduce this operation into English surgery, and who has had much practical experience at the Brompton Hospital. This operation will be the best where the patient is in good condition, and the surgeon, having had experience, can operate rapidly.

The hæmorrhage, which is free and by no means a light matter in many of these patients, should be effectively controlled by the application of Spencer Wells' forceps and thoroughly applied sponge-pressure. Any that is especially difficult to arrest will cease as soon as the pieces of ribs are removed and the cut intercostal arteries clamped.

In the other case, where several incisions and smaller flaps are made use of, small incisions being made at right angles to the long ones, and flaps of skin and fascia, parallelogram in shape, raised, the muscles are then peeled off each rib with a blunt dissector or slightly curved elevator. Whichever method is employed, care must now be taken to leave the periosteum on the rib (the only

FIG. 144.



Schede's incision for thoracoplasty. The curved incision shows the large flap; the dotted one, the line along which the ribs are resected.

safe guide being not to strip off all the muscles), and by no means to detach it. If it be left behind, it will throw out callous material, which will be as unyielding as the bones removed. The elevator is then slipped under the rib, run along, close to its posterior aspect, to one limit of its bared surface, and the rib, divided here either with a narrow strong-backed saw—an osteotomy saw or a Fergusson's jaw-saw answers the purpose excellently—or with cutting forceps. The rib being then raised up when cut, is divided again at a corresponding spot, and as many as is desirable treated in the same way. Each piece of rib should show clean cut surfaces at either end, and be covered with periosteum. Throughout the operation the surgeon's finger should keep him accurately informed as to the limits of the cavity, especially when he approaches these in dividing the ribs.

Mr. Godlee advises removing as much as possible of the thickened pleura, which is now exposed, and, with it, any periosteum which has been left behind. Some square inches of this may be taken away without fear of serious hæmorrhage, if it is snipped through gradually with curved blunt-pointed scissors, the vessels met with being easily secured.

The cavity may now be thoroughly explored with the finger or a soft catheter. If fetid, or lined with ill-formed lymph, it may be gently scraped out with a sharp spoon, great care being taken when this comes in contact with important parts, such as the pericardium, root of the lung, &c. Iodoform or Jeyes' dusting powder should be blown in, and, where there is much fœtor, the *ends* of the gauze strips with which the cavity is plugged should be wrung out of turpentine. Drainage-tubes are then inserted, if needful, and if a large flap has been raised, this is secured *in situ* with a few points of suture. If, on the other hand, multiple small flaps have been raised, no sutures should be inserted, as primary union cannot take place, and discharges might be pent up.

The wound, at the bottom of which probably lies the lung covered over only with visceral pleura, is lightly filled with strips of aseptic gauze or boracic-acid lint and salicylic wool or carbolised tow retained with a many-tailed bandage. If strict precautions are taken by cleansing the instruments, irrigating carefully, and keeping the wound covered with carbolised lint whenever practicable sepsis will be preserved. All sources of chill and shock should be avoided.

With regard to the date at which ribs should be partially resected in long-standing cases of empyema, most surgeons who have seen much of these troublesome cases will, I think, agree that the operation should be performed as soon as the natural powers of obliteration are at a standstill, care being taken that the patient has recovered from the effects of the first operation, and perhaps recruited his strength at the seaside.

Estlander, who first introduced this operation, advises, on the

other hand, that the operation should not be made use of too early, as he considers it essential that the two layers of pleura should be changed into thick, firm connective tissue, for the operation to succeed. Thus an interval of about six months after the formation of the empyema would seem, according to this view, to be the proper time for resection of ribs; but, on the other hand, too unyielding a condition of the chest walls, too thick a layer of scarred pleura and pyogenic membrane are conditions not to be waited for.

C. *Wound of Intercostal Artery*.—When hæmorrhage from one of these vessels cannot be otherwise dealt with, removal of a rib will give much readier access to the spot, and a ligature will arrest the bleeding far 'more satisfactorily than the ingenious devices mentioned in the text-books.

D. *For Removal of Growths*.—An attempt may be justifiably made to remove a growth arising from the ribs if the following conditions are favourable. The growth should be of moderate size, not involving parts of more than four ribs, its history should be a slow one, its outline should be nodulated, well defined, and its surface hard, pointing to a chondroma or osteo-chondroma, the skin over it thinned, perhaps, but not infiltrated. There should be no dulness in the neighbourhood of the growth, the breath sounds should be normal, and there should be no enlargement of the axillary or the inguinal glands. The following is a successful case :

Zarubin, of Kharkov, relates (*Trans. of the Kharkov University Society*, 1891, *Supplement to Brit. Med. Journ.* August 1, 1891) the case of a young Cossack, who sought his advice for a steadily growing and occasionally painful tumour, of seven years' standing. It measured 21 centimetres horizontally, and 19 vertically, occupying the right side of the chest between the nipple and the post-axillary line, from the sixth to the ninth rib. The new growth was hard, nodulated, immovable, and non-adherent to the skin. The integuments over it were thinned but otherwise normal, and the nearest lymphatic glands apparently unaffected. An osteo-chondroma of the thoracic wall was diagnosed. The huge mass was removed, together with the involved portions of the seventh, eighth, and ninth ribs. The gap left in the chest measured 17 centimetres in a horizontal, and 16 in a vertical direction. On opening the thoracic cavity the lung collapsed, but only partially, owing to pleural adhesions around the periphery of the new growths. No serious respiratory or cardiac disturbances occurred, and the hæmorrhage was only trifling. The cavity was gently cleansed with gauze, soaked in a 1 per cent. solution of boracic acid, and the skin wound, conical in shape, closed. The growth, much larger than an adult head, weighed over six lbs. For the first two days the patient was much collapsed and cyanosed, and suffered from agonising cough and obstinate vomiting. The healing of the wound was complete in two months. The author alludes to ten other cases of resection of the thoracic wall for new growths, of which six recovered, while four died.

The following are cases unsuitable for operation :

Seydel, of Munich, reports (*Centr. f. Chir.* No. 51, 1890) a case of sarcoma of the ribs in a man aged twenty-two, which dated to an injury and grew rapidly. At the operation the growth was found to have extended to the liver. It soon recurred *in situ*, and the patient died a little later with secondary deposits in lungs and liver.

Dr. Park, of Buffalo (*Ann. of Surg.*, 1888, p. 254), relates a case in which he removed part of the chest-wall for a sarcoma. This was secondary to a small round-cell sarcoma of the leg, for which amputation through the knee-joint had been successfully performed. The growth was about the size of a hen's egg, a little above and to the outer side of the left nipple, fixed, and tender; the skin over it was movable and no enlarged glands could be made out. There was no dulness on percussion in the neighbourhood of the growth, the chest expansion was normal, and on careful auscultation no difference could be detected in the sounds of the two lungs.*

At the operation by a crucial incision, flaps were turned back, and four ribs—fourth, fifth, sixth, and seventh—were found to be involved, necessitating the removal of part of the chest wall some 5 inches in length by $3\frac{1}{2}$ in width. Numerous sarcomatous nodules were scattered throughout the left lung. Towards the close of the operation the pulse was 140 and very weak, the respirations 30, but regular in rhythm, and there was slight cyanosis of the face. Save for great pain, the patient did well for a few days, but sank at the end of the week. At the autopsy the cavity of the left pleura was found filled with a bloody serum, free from odour. The lung was soft and tore easily. Both lungs were studded with sarcomatous nodules.

* Dr. Park points out that this point may be explained by the fact that the two lungs were equally affected by secondary deposits.

CHAPTER III.

DRAINAGE OF LUNG-CAVITIES.

Indications.—Operative interference is justifiable where there is a lung-cavity due to bronchiectasis, gangrene,* or hydatid, and most of the following conditions are present.

When previous treatment has failed, when it is evident that the cavity is insufficiently drained through a bronchus,† and the consequent abundant muco-purulent, fetid expectoration exhausts the patient, with harassing cough, irritative diarrhoea, and commencing hectic. When the cavity is limited and can be accurately localised,‡ when the surrounding lung-tissue is not yet infected, and the opposite lung is healthy. When the cavity is sufficiently near the surface to be got at, and when it is in a region that can be safely attacked.§ When that part of the pleural sac which overlies the lung-cavity is obliterated.||

The two American writers quoted below show that adhesions may be expected when the abscess cavity is large, or where several attacks of disease have occurred in that part of the lung in which the cavity now exists. If the surgeon is in doubt as to the condition of the pleura here, he should make an incision down to the intercostal muscles, pass a needle into the lung, and watch it during respiration. If it does not move synchronously with this, there are certainly adhesions.

* Mr. Godlee (*Lancet*, 1887, vol. i. p. 459) is of opinion that most gangrenous abscesses are the result of acute pneumonia, and situated near the bases. The occasional existence of a foreign body as a cause of the trouble—viz., a piece of bone or a blade of grass, &c.—should not be forgotten.

† If the surgeon wait too long in dealing with a gangrenous abscess, fetid fluid from this may, by getting into the bronchi, reach the other lung, and set up most serious damage there.

‡ In other words, when the whole bronchial tree is not dilated in one and perhaps both lungs (Dr. Williams, *Med. Chir. Trans.*, vol. lxxix. p. 317).

§ Drs. Fenger and Hollister, of Chicago (*Amer. Journ. Med. Sci.*, 1882, vol. ii. p. 370, a paper which will well repay reference), point out that a cavity covered by the scapula, or in the supra-scapular region, must be at present considered inaccessible. Access can be best got from the mammary and axillary regions.

|| This point is of the greatest importance, chiefly from the probably foul nature of the cavity contents, and the risk of setting up a fetid pyo-pneumothorax when the lung-cavity is opened, and even graver and much more urgent danger from cutting into a healthy pleural cavity.

The co-existence of empyema, of pleurisy, of a tendency to general bronchitis, will be examined into, and the amount of each and its importance in prognosis duly weighed. Finally come more general points—*e.g.*, the age of the patient and the history.

In endeavouring to estimate the size of the cavity before exploring it, the following possible fallacies will be remembered :

Dr. Williams (*loc. supra cit.*) points out that (1) the empyema which invariably accompanies the globular form of bronchial dilatation often entirely masks the physical signs of a cavity, even when the patient's sensations and the amount and character of the expectoration point to the presence of a bronchiectasis ; (2) That the character of the cavernous sound heard over bronchial dilatation is so jarring in tone that it is audible over a far larger area of chest wall than that immediately overlying the cavity. On this account the size of the bronchiectasis is often thought to be larger than it eventually proves to be.

Mr. Godlee, in his lectures, to which I have already referred, shows that the amount of expectoration is no criterion as to the size of the cavity, as each pellet irritates the bronchi in its way over them, and causes a great secretion of mucus.*

Operation.—The anæsthetic should be given slowly to avoid coughing, and the patient kept on his back as much as possible, these two precautions being intended to prevent fluid, coughed out of the cavity, dangerously obstructing the bronchi.

If the exact position of the cavity is doubtful, a preliminary aspiration or exploring trocar-puncture † should be made use of.

An incision $1\frac{1}{2}$ inch long ‡ is then made, taking the needle or trocar, if used, as a guide, in the middle of an intercostal space down to the muscles, which are next torn through. The lung-tissue with the overlying pleura § is, perhaps, best opened with a medium-sized trocar and cannula, and the opening then dilated with dressing-forceps. The finger is then gently inserted to ascertain whether any dead cast-off lung-tissue || is present.

* Thus, this surgeon has cured by incision a cavity which, really holding only an ounce, caused expectoration of more than a pint.

† With reference to this step, Mr. Godlee's remark should be remembered. "It is impossible to penetrate the lung with any amount of accuracy or definiteness, because it recedes before even the sharp point of a needle."

‡ It is wise to make a sufficiently free incision to prevent the risk of subcutaneous emphysema. In one case fetid emphysema took place and disappeared.

§ In addition to the aids already given for deciding as to whether the pleura is adherent or not the state of the intercostal spaces may help, *i.e.*, whether they are depressed on deep breathing.

|| Rokitsansky (*Path. Anat.*, Syd. Soc. transl., vol. iv. p. 96) speaks of having met with a walnut-sized piece of dead lung in circumscribed gangrene of that viscus. Wagner (*Berl. klin. Woch.*, September 6, 1880) removed a piece of gangrenous lung-tissue by an opening made for evacuating an empyema, the patient recovering. In some cases broken-down lung-tissue may be all that is met with, very little fluid, if any, being present.

and to find out the lowest point at which to make a counter-opening.*

A full-sized drainage tube should be inserted, soft, for fear of hæmorrhage from friction and ulceration, and sufficient aseptic dressings, iodoform or sal-alembroth gauze with salicylic wool, applied.

As a cavity which gives unequivocal evidence of its existence may be missed † by making one puncture and then incising at that spot, and as the exploring finger or director may push the cavity to one side, the lung should be explored at several spots if needful. If the pleura is not adherent over the cavity, it will be but little good stitching the lung so as to obliterate the pleural sac here, as stitches so used are very difficult of insertion and soon cut out (Godlee). If any foul fluid escape into the pleural cavity, this must be treated like an empyema (p. 574).

Hæmorrhage is not commonly met with after puncturing the lung, as this is probably solidified and altered round the abscess cavity. If it be severe, the cavity must be plugged with aseptic gauze wrung out of turpentine. When any rotten lung-tissue has been removed with the finger, hæmorrhage is to be expected.

If the cavity be due to an hydatid, the cyst-wall may perhaps be expelled when coughing is set up by the incision of the cavity. If it does not so come away, it should be removed, if this can be effected, without setting up hæmorrhage. A good instance of how large cavities in the lung may be, when due to this cause, is given by a case of Dr. Fenger's (*Lond. Med. Rec.*, 1881, p. 327), in which he successfully operated by an incision in the third space (through adherent pleura), on a gangrenous hydatid cavity in the right lung, reaching from the second to the fifth rib, and from the sternum to the posterior axillary line.

After-treatment.—The cavity should be syringed out with a 1 in 50 solution of carbolic acid, till fœtor disappears and then with thymol lotion. If fœtor is obstinate, gentle plugging with gauze wrung out of turpentine should be tried. The drainage-tube must be retained until the cavity has almost completely closed—*i.e.*, until the discharge has almost, and the expectoration has quite, stopped. If the tube be removed too early, refilling

* It is wiser to make two openings, one at the most superficial part; then from this to explore the cavity and to try and find the lowest part for making a counter-opening, and thus to secure complete evacuation. Simple drainage with a single opening is often not sufficient, washing out being usually required to arrest the fœtor. If this washing out be done from a single opening, the fluid, having no escape, irritates the bronchi and sets up much cough. The counter-opening is best made on some unyielding body, such as a sound. Occasionally the cavity comes to the surface at several points.

† It is possible that, after such a fruitless exploration and the insertion of a drainage-tube, pus may burst into it, as happened in Dr. Cayley and Mr. Gould's case (*Med. Chir. Trans.*, vol. lxxvii. p. 209), but this did not happen in a case of Mr. Godlee's, though the patient recovered. While the puncture may yield no fluid, gas may escape, showing that gangrenous lung has been reached.

of the cavity, with return of fever, nausea, expectoration, &c., are certain. Moreover, as the external opening tends to close before the cavity is obliterated, any foul remaining matter which does not escape will be drawn into the bronchi and set up diffuse bronchitis and broncho-pneumonia.

The general health must be sustained, and every attempt made to secure fresh air, whether in the patient's room, or by getting him as soon as possible into another room, and out-of-doors.

Even if the operation does not save life, it may make the remainder much more comfortable both to the patient and his friends.

Dangers and Difficulties in Opening a Lung-Cavity.

1. Dyspnœa, coughing and choking expectoration with the anæsthetic (p. 584).

2. Pleural adhesions absent (p. 583), or so soft that they easily break down, the lung thus being pushed away from the ribs (Godlee).

3. Missing the cavity and damaging healthy lung-tissue. This is best avoided by careful preliminary use of an aseptic fine trocar or large morphia-needle.

4. Getting, as a result of the operation, diffuse broncho-pneumonia, pleurisy, pleuro-pneumonia, in the lung operated on or its fellow.

5. Severe hæmorrhage, causing much trouble, owing to the hæmoptysis, with the anæsthetic (Godlee), and later on setting up septic inflammation of the lung.

6. Finding a large branching cavity, with numerous caverns, difficult or impossible to drain.

7. If the bronchi are dilated and contain fluid similar to a cavity, this may be drawn from a bronchus by preliminary puncture. This is then mistaken for a cavity, and cut down upon.

8. A cavity near the root of the large vessels.

9. Much consolidation of the lung-tissue over the cavity.

10. As a result of the operative interference, secondary rapid sloughing and gangrene of the lung may follow.

This seems to have happened in an interesting case reported by Dr. J. Smith, of Halifax (*Lancet*, 1880, vol. ii. p. 86). Decided relief and improvement followed on the opening of what was apparently a large cavity, but death took place in about a fortnight.*

* The conclusions with which Mr. Godlee (*Lancet*, 1887, vol. i. p. 718) sums up his most valuable lectures on this obscure and difficult subject may be quoted here:—"1. Gangrenous cavities should always be sought, and, if possible, opened; and the prognosis, if the operation be successful, is not bad. 2. The same may be said in regard to abscesses caused by the rupture of purulent collections from other parts into the lung, at least as regards the pulmonary complication. 3. Abscesses connected with foreign bodies must be opened, and, if the body be not found, it must be remembered that, if of any considerable size, it probably lies pretty near the middle line. If possible, these cases should be treated early

by tracheotomy and incision. 4. Bronchiectatic cavities, when single (a very rare condition), will be cured by operation. When multiple (a very common condition), they offer but small chance of relief by our present surgical methods. Still, for the reasons stated, an attempt may be made to open the main one, if such is to be found, but only if the pleura has been ascertained to be adherent. 5. Tubercular cavities should only be opened in cases where the cough is harassing, and the cavity single. Injections may be used to relieve symptoms, but cannot be expected to be curative."

CHAPTER IV.

TAPPING OR INCISING THE PERICARDIUM.

Indications.

1. When a pericardial effusion has resisted previous treatment, and signs of cardiac distress are appearing.
2. When there is a steady increase of precordial dulness.
3. When the heart-beat and pulse are becoming feeble..
4. When cyanosis, dyspnoea, and epigastric distress are present.
5. When the effusion persists, when it is accompanied by oedema, rigors, and pyæmia, when it occurs in a much weakened patient, as part of pyæmia, the fluid is probably purulent.*

The most suitable place for puncture is, in ordinary cases, the fifth,† left intercostal space, about 1 inch from the edge of the sternum, so as to avoid the internal mammary artery,‡ the instrument being a trocar and cannula, with or without aspiration according to the facility with which the fluid flows.§ A pint of serum, and in many cases over a pint, has been removed. The withdrawal of a much smaller amount—viz., 3 or 5 oz.—has been followed by recovery.||

Dr. Goodhart points out to me that the position of election is

* In Dr. West's case (*Med. Chir. Trans.*, vol. lxvi. p. 266), treated successfully first by tapping and then by free incision, there were no rigors or sweating, but oedema of the chest walls, most marked over the precordial region, was present. So, too, in a patient of Prof. Rosenstein's, a boy aged ten, with a large purulent pericardial effusion, the temperature was hardly above normal, and there was no oedema.

† The fourth space has also been chosen in many cases.

‡ And also to avoid opening the pleura. When this is adherent to the pericardium, the tapping or incision can, of course, be made further out. But Dr. West, who chose the nipple line for his puncture and opening as the spot where the heart was farthest from the chest walls, found that a long sinus formed—an argument for puncturing nearer the sternum.

§ In Dr. West's case the pus was very viscid, and flowed slowly; the cannula was accordingly connected with the aspirator, and about 14 oz. obtained.

|| With regard to the amount to be withdrawn, Dr. Stewart (*Edin. Med. Journ.*, August 1885) thinks that, if serous fluid is found, aspiration should be made use of, but only enough withdrawn to give relief. He points out that it is a sound rule, in dealing with vital organs, that only a minimum amount of interference should be had recourse to, and that this is especially necessary in cases which threaten pulse-failure. The tapping should be repeated rather than too much fluid be drawn off at once.

still an open question, each case calling for a decision by itself. The puncture has been made in the fourth or fifth space in the left nipple line or even beyond this. Dr. Goodhart considers that the second of the above sites would give the best drainage with least disturbance to the heart if the effusion were sufficient to allow of the above space being chosen. This method involves going through the pleura, and if this serous space contain fluid, the surgeon may evidently be mistaken in thinking that he has reached the pericardium. This has happened twice, to my knowledge, each being a case of thoracic growth. In one of them, a case of mine, the pleura was opened by tapping in the fourth space, just outside the sternum; the fluid which flowed was thought to come from the pericardium, until an autopsy proved that this sac was intact. Such cases prove that entering the pericardium is by no means as easy as is usually taught.

A preliminary puncture being made with a scalpel, the trocar—in the case of serum, a hydrocele trocar will probably be sufficient—scrupulously clean, should be steadily pushed, with aseptic precautions, for $1\frac{3}{4}$ or 2 inches through the chest wall, and at a right angle* to it. The trocar should then be removed, and, if fluid does not flow, the point will probably be found not to move freely in a cavity. It should then be pushed cautiously onwards, and its point at once sheathed if it is felt to touch against a soft obstacle.

On the fluid ceasing to flow, the puncture should be closed with collodion and iodoform.

Dr. West thinks (*loc. supra cit.*) that paracentesis pericardii may be performed with advantage, not only in the pericardial effusions of rheumatic or primary origin, but also in those which occur in the later stages of general dropsy, if it should appear that the fluid in the pericardium is adding to the difficulties under which the heart is placed. According to the cases which he has collected, with one exception† all the patients were much relieved by the removal of even a small amount of fluid, and many recovered completely who would probably have died if the operation had not been performed.

The co-existence of effusion into the pleuræ and peritonæal cavity in many of these cases must be remembered.

If pus is present, the case must be treated by free incision. An anæsthetic being given,‡ the trocar is taken as a guiding-director,

* Mr. Godlee (*Dict. of Surg.*, vol. ii. p. 164) says close to the sternum, and obliquely upwards and outwards, so as to avoid wounding the heart.

† In this case, No. 51 in Dr. West's list, death took place, five minutes after the puncture, from hæmorrhage into the pericardium from injury to the right ventricle. But in another case, No. 29, the patient died two hours after the operation, the left pleura being found to contain air and blood, the latter coming from a puncture in the heart.

‡ Chloroform will perhaps be the wisest, especially if pleural effusion co-exists,

and a narrow sharp-pointed bistoury carefully thrust in by its side; the opening is then further dilated with dressing-forceps or a blunt-pointed bistoury, care being taken to keep the internal opening into the pericardial sac free. A large soft drainage-tube should next be inserted, and, when all the pus* that will come away has escaped, aseptic-gauze dressings should be applied.

Dr. Gussenbauer, in a patient aged fifteen, with purulent pericarditis after osteo-myelitis, resected part of the fifth rib before incising the pericardium, and the patient recovered. While this is an improvement on the now abandoned method of trephining the sternum, it cannot often be required.

Causes of Failure.

1. The heart fatty or dilated. These changes may come on very rapidly.
2. The pericardium much thickened and adherent.
3. Co-existing effusions into pleuræ and peritonæal cavity.
4. Œdema of lung. Evidence of this should be most carefully watched for. This proved fatal in the case of a patient of Dr. Goodhart's, a young lady of fourteen, from whose pericardium I removed 46 oz. of pus by an incision in the fifth right space, a little outside the sternum.
5. Co-existing diseases—*e.g.*, phthisis, or renal disease.

on account of the greater struggling with ether. Punctures for cocaine injection will be painful, and very likely futile.

* In Dr. West's case, a boy aged sixteen, this was estimated at 2 quarts. If the pus is foul, but not otherwise, the cavity should be syringed out with dilute carbolic acid or mercury perchloride solution.

PART IV.

THE ABDOMEN.

CHAPTER I.

LIGATURE OF VESSELS.

EXTERNAL ILIAC. COMMON ILIAC. INTERNAL ILIAC.
GLUTEAL. SCIATIC. ABDOMINAL AORTA.

LIGATURE OF THE EXTERNAL ILIAC (Fig. 145).

Indications.—Chiefly :

1. Some cases of aneurism of the upper part of the femoral, or of the femoral encroaching on the external iliac itself.* Thus, ligature of this vessel is indicated where pressure, rapid or gradual, has failed to command the circulation, where it is intolerable, where it cannot be made use of owing to the abundance of fat, from failure of pulse and breathing under an anæsthetic, or from the height at which the aneurism involves the external iliac,† where the patient from chronic bronchitis is quite unfit for a prolonged trial of continuous pressure under an anæsthetic, or in cases where the increase of the aneurism is very rapid.

Before deciding on relinquishing the idea of pressure for ligature, the surgeon should refer to a paper by Mr. Wheelhouse (*Clin. Soc. Trans.*, vol. vii. p. 57). This case is one of the most interesting in all surgery.

The patient, a publican, and syphilitic, had previously been cured by Mr.

* Mr. Holmes (R.C.S. Lect.: *Lancet*, 1873, vol. i.) shows that in ilio-femoral aneurisms it is often very difficult to say whether the aneurism is or is not limited to the iliac or femoral—i.e., whether it is wholly above or below the place where the deep epigastric and circumflex iliac come off, or whether the mouths of these vessels open out of the sac. In the former case the aneurism would be purely iliac or femoral; in the latter, ilio-femoral.

† It being increasingly difficult to apply pressure in these cases without dangerous interference with the peritonæum and its contents.

Wheelhouse of a right-sided popliteal aneurism,* by means of continuous pressure for eight hours with a Porter's femoral-compressor. A few months later he was admitted into the Leeds Infirmary with a large right iliac aneurism,† reaching from Poupart's ligament to within 2 inches of the umbilicus, and extending outwards almost to the spine of the ilium. The swelling, about the size of a small cocoa-nut, was hard and firm below, soft above; it appeared to be wholly connected with the external iliac, but to extend above and overlie the common iliac. Pressure could not be made on the latter vessel sufficient to stop the beating, as the tumour was too much in the way, but it was easily controlled by pressure on the abdominal aorta. The patient was kept under the influence of ether for five hours, Lister's tourniquet being very slowly screwed down just over the umbilicus. By the end of the time the patient was black in both limbs, and blue as far as the tourniquet. This had been slightly relaxed twice. No other unpleasant symptom arose during the whole time. A quarter of an hour was taken in relaxing the pressure—a quarter turn of the handle being made every minute. The tumour had ceased to pulsate and was firm and hard. Pulsation gradually recurred with nearly its old force, but was less “distensile,” and slowly ceased altogether, an excellent recovery being made.‡

* It is very possible that the strain thrown on the artery above during the treatment by pressure on the femoral was the cause of the aneurism higher up. The liability of patients with one aneurism to develop another may often baffle the surgeon. Mr. Clutton (*Brit. Med. Journ.*, 1880, vol. i. p. 441) records a case in which a femoral aneurism was cured by the use of Esmarch's bandage applied up to the tumour, and a Pétit's tourniquet adjusted over the brim of the pelvis. The first attempt lasted an hour; at the second trial the bandage was removed in an hour, and the tourniquet continued for nine hours, anæsthetics not being given. The aneurism ceased to pulsate and began to shrink, but still fluctuated. Nine days after leaving the hospital, the patient died suddenly of an aortic aneurism rupturing into the pericardium.

† Dr. Diver, of Southsea, has put on record a case in which the external iliac was tied in a case in which a popliteal and inguinal aneurism co-existed on the right side. Gangrene followed, a line of demarcation forming in the lower third of the leg. Amputation through the thigh was performed, and the patient recovered. A similar case of double aneurism is reported by Mr. Hilton (*Med. Chir. Trans.*, vol. lli. p. 309). A tourniquet was first applied to the right common iliac for six hours without effect on the aneurisms. A second trial of pressure was made, later on, with a tourniquet again on the common iliac and one on the femoral at the apex of Scarpa's triangle. In about nine hours both aneurisms were cured. Chloroform was used on both occasions.

‡ Cases of Dr. Mapother's and Mr. Holden's, in which ilio-femoral aneurisms were cured by pressure on the common iliac and the aorta, will be found, recorded by Dr. Mapother, in the *Dub. Med. Press*, March 29, 1865, and by Mr. Holden, in *St. Barthol. Hosp. Reports*, vol. ii. p. 190; *Syd. Soc. Bien. Retr.*, 1865-6, pp. 306, 307. In Dr. Mapother's case, instrumental pressure on the right common iliac (about 1 inch below and $\frac{1}{2}$ inch to the right side of the umbilicus) kept up for twelve hours under chloroform had failed. A second attempt, with a Signorini's tourniquet on the end of the abdominal aorta, and a Skey's tourniquet on the femoral just as it left the sac, pressure being kept up for four hours and a half, made the tumour solid and pulseless. Two rigors followed, and a carbuncle formed at the site of the first compression. In Mr. Holden's patient the aneurism was also large, and double aortic valvular disease was present. Chloroform was given here continuously for an hour and a half, and then with cautious intermissions, owing to the state of the pulse and breathing, for the rest of the treatment, which lasted four hours.

In ruptured * femoral aneurism the old operation (facilitated by the application of a tourniquet above) would usually be indicated, but Mr. Southam has briefly reported † a case in which he tied the external iliac successfully in a patient whose femoral aneurism suddenly ruptured and became diffuse. The effused blood was quickly absorbed, and there was never any tendency to gangrene. Complete power over the limb was regained.

2. Wounds.—A wound of the external iliac is so rare as to be almost unknown.‡ It has been frequently tied for hæmorrhage from parts below—*e.g.*, for secondary hæmorrhage after wounds of the femoral high up, after ligature of the femoral, and after amputation at or near the hip. The futility§ of this treatment is thus shown:

Dr. Otis|| gives a summary of twenty-six cases in which the external iliac was tied for such cases as the above. Of these, twenty-three ended fatally, a mortality of 88.4 per cent. The uselessness of trusting to ligature of the external iliac in such cases, instead of either securing the wounded vessel itself, or trusting to well-applied pressure, was long before this insisted on by Guthrie.¶ This question is alluded to again below, but in proof of the above statement a case ** may be mentioned here, in which hæmorrhage returned after ligature of the external iliac, and was arrested by well-applied pressure. The patient had been wounded, January 15, 1865, by a minié ball, entering at the upper and inner part of the thigh, and emerging near the knee. The wound becoming sloughy, hæmorrhage occurred—March 23 and 31—and the external iliac was tied. April 21. Hæmorrhage recurred from the upper gun-shot wound, and was successfully restrained by a horseshoe tourniquet, constantly kept on for two weeks, when it was omitted, without any subsequent hæmorrhage. The wounds were now healing kindly, when—May 31—dysentery set in, carrying off the patient, June 15, two and a half months after the operation of ligature.

3. Elephantiasis. — Ligature of the external iliac or femoral (when the condition of the soft parts admit of it) has been ex-

* In an interesting case recorded by Dr. Sheen, of Cardiff (*Brit. Med. Journ.*, 1882, vol. ii. p. 720), the femoral aneurism, for which the external iliac was tied successfully, changed its shape suddenly, having burst some of its coats, apparently, but not all, on the day of operation.

† *Brit. Med. Journ.*, 1883, vol. i. p. 818.

‡ The only case with which I am acquainted is one quoted by Mr. Erichsen from Velpeau (*Nouv. Elém. de Méd. Opér.*, t. i. p. 175), in which the above French surgeon was suddenly called upon to tie the external iliac for a knife-wound. Though there had been no preliminary dilatation of the collateral circulation either by pressure or by the presence of an aneurism, the result was successful.

§ It is fair to state that Mr. Bartleet, of Birmingham, published a case in which the external iliac was tied successfully after secondary hæmorrhage from the common femoral, the latter having been tied for aneurism of the femoral artery. Previous to ligature of the external iliac, "sponge-pressure" and pressure by means of a Martin's bandage were tried, but no details are given. It is noteworthy that the catgut ligature applied to the femoral in this case came away on the seventh day (the first day of the hæmorrhage) unobserved, and surrounding a small slough of the artery. It had been tied "tightly."

|| *Med. and Surg. History of the War of the Rebellion*, pt. iii. p. 788.

¶ *Wounds and Injuries of the Arteries*, Lects. v. and vi.

** Otis, *loc. supra cit.*, p. 40.

tolled by some surgeons in the treatment of this affection.* A larger experience shows, however, that when cases thus treated are watched, the cures cannot be relied upon as permanent. Moreover, too little value has been attached, in reported cures by ligature of the main vessel, to the thorough rest and elevated position entailed by tying the artery.†

This operation should, I think, be reserved for those cases (which will be very few) in which Martin's bandages cannot be applied, owing to cracks, foul ulcers, or burrowing sinuses. Here the ligature may be used after explaining its risks to the patient, but only as a subsidiary measure. The bandage will have to be used as well later, and persisted in, during the day at least, probably for life.

4. As a distal operation in aneurism of the common iliac, ligature of the external iliac has been so unsuccessful here as to call for no further comment.

Surgical Anatomy.

EXTENT.—From the lumbo-sacral articulation to a point just internal to the centre of Poupart's ligament. LENGTH.— $3\frac{1}{2}$ to 4 inches.

SURFACE MARKING.—From a point an inch below and to the left of the umbilicus to a point just internal to the centre of Poupart's ligament.

RELATIONS :—

IN FRONT.

Peritonæum, small intestines.

Iliac fascia.

Lymphatic glands and vessels.

Genito-crural nerve (genital branch).

* An apparently successful case is reported by Mr. Leonard, of Bristol. Measurements are given nearly three years after the operation, showing that the success was then maintained. Five years later the patient reported that "his leg was much the same" as at the last report. Bandaging does not appear to have been made use of here. Prof. Buchanan (*Brit. Med. Journ.*, November 23, 1867; *Syd. Soc. Bien. Retr.*, 1867-8, p. 300) reports a case, seven months after the operation, apparently cured by ligature of the external iliac, after failure of rest and methodical compression (this was before the introduction of Martin's bandage). Three months later it is candidly stated that the disease had recurred to a considerable degree. Dr. White, of Harvard University (*Intern. Encycl. of Surg.*, vol. ii. p. 631), quotes Wernher (reference not given) as having followed up thirty-two cases; in all there was an immediate reduction of size, but the relief was permanent in three only. Dr. Pinnoch, of Melbourne (*Lancet*, 1879, vol. i. p. 44), gives a case in which no permanent benefit followed on ligature of the femoral artery.

† A severe case of Mr. Whitehead's is briefly reported in the *Brit. Med. Journ.*, 1882, vol. ii. p. 1043. The disease had lasted seventeen years, and had been associated with attacks of erysipelas. "The treatment (successful) had consisted in rest, massage, elastic pressure, compression of the femoral artery, and rubbing down the tubercles with pumice-stone. The knee, which had become flexed and ankylosed by bony union, was straightened by sawing through the site of the original joint."

Spermatic vessels	}	Crossing artery near Poupart's ligament.
Circumflex iliac vein		
OUTER SIDE.		INNER SIDE.
Psoas (above).	External iliac	Iliac fascia.
Iliac fascia.	artery.	Vein.
	BEHIND.	
	Iliac fascia.	Vas deferens (dipping
	Vein (above).	from internal ring
	Psoas (below).	to pelvis).

Collateral Circulation.

Deep epigastric	with	Internal mammary, lower intercostals, and lumbar.
Deep circumflex iliac	with	Ilio-lumbar, lumbar, and gluteal.
Gluteal and sciatic	with	Internal and external circumflex.
Comes nervi ischiadici	with	Perforating branches of profunda.
Obturator	with	Circumflex arteries and epigastric.
Internal pudic	with	External pudic.

Operation.—(1) By the lower and more transverse incision of Sir A. Cooper. (2) By the higher and more vertical incision of Abernethy. The two are compared at p. 598. (3) By the intra-peritoneal method. (p. 612).

(1) **INCISION OF SIR A. COOPER.**—This is the method more frequently made use of. The diet having been limited, and the bowels having been freely moved for some days before the operation, the parts shaved, and the hip slightly * flexed, an incision is made 4 inches long ($4\frac{1}{2}$ to 5 if there be very much fat, or if the parts are pushed up by a contiguous aneurism), parallel with Poupart's ligament, and nearly an inch above it, commencing just outside the centre of the ligament and extending outwards and upwards beyond the anterior superior spine.† The superficial fascia and fat, varying in amount, being divided, and the superficial circumflex iliac vessels secured, the external oblique, both fleshy and aponeurotic, is cut through, and then the fleshy fibres of the internal oblique and transversalis. This is done either by using the knife alone, lightly and carefully, or by

* So that the skin may not be too much relaxed before being incised. Later on, to relax the parts, the hips may be more strongly flexed.

† The incision may have to be made higher than usual, owing to the upward extension of the aneurism, to enable the surgeon to tie either the upper part of the external or the common iliac. On this point see the remarks on the comparison of Cooper's and Abernethy's operation, p. 598. Often in these cases of upward extension of the aneurism, the sac is found to involve the lower part of the artery, and to have overlapped the upper portion.

taking up each layer with forceps, nicking it and slitting it up on a director. If the wound be sponged carefully,* a layer of cellular tissue can usually be seen between the muscles, however thin they are. Any muscular branches should be secured with Spencer Wells' forceps as soon as cut; and in pushing a director beneath the muscles as little damage as possible should be done, owing to the proneness to cellulitis later on, and to the proximity, in a thin patient, of the peritonæum. The fascia transversalis, when exposed, will be found to vary a good deal in thickness and in the amount of fat which it contains. It is to be divided very carefully,† and the extra-peritonæal fat, if present, will next come into view. First one and then two fingers being introduced, the peritonæum is to be gently stripped up from the iliac fossa towards the middle line—*i.e.*, upwards and inwards as far as the inner border of the psoas.‡ In doing this care must be taken, especially in the dead body, not to separate the iliac fascia and the vessels from their position on the psoas, not to tear this muscle, and not to lacerate the peritonæum. As soon as the peritonæum has been well raised, an assistant keeps this and the upper lip of the wound well out of the way by means of broad retractors. The surgeon then feels for the pulsation of the artery on the inner border of the psoas, and carefully opens the layer of fascia which ties the vessel to the psoas, and forms a weak sheath to it. This should be done $1\frac{1}{4}$ inch above Poupart's ligament,§ and the needle passed from within outwards, carefully avoiding the vein on the inner side and the genito-crural nerve outside and in front. In difficult cases the ligature (of sterilised silk, or kangaroo-tail) must mainly be passed by touch, but a free

* In some cases where the circulation has been much interfered with by an aneurism, most copious hæmorrhage, especially venous, has been met with in the earlier steps of this operation.

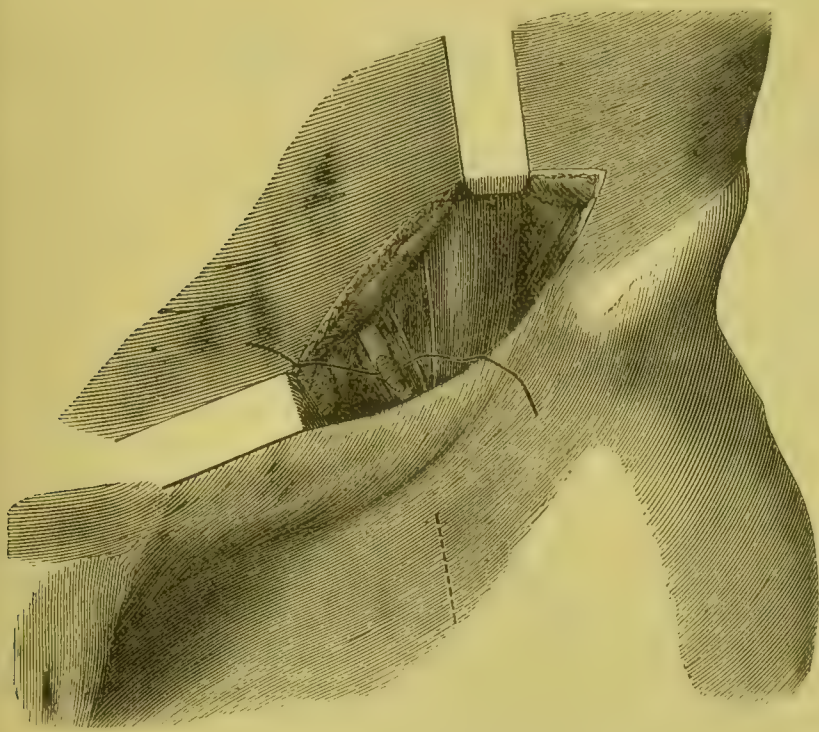
† Dr. Sheen (*loc. supra cit.*) thus writes of the accident which may happen here; "I made the incision somewhat too high, and, in consequence, opened the peritonæum, which I mistook for transversalis fascia. Even then I was in a little doubt, because some (omental) fat presented itself, which very much resembled the fat seen in the previous case (fat around the vessel), but, in pushing this up gently, a knuckle of bowel came into view, which settled the matter." The wound in the peritonæum was sewn up with two fine carbolized sutures, and the case did perfectly well.

‡ Great care is needed here if the peritonæum is adherent. This condition, when present, is usually found above. It is especially likely in long-standing cases, and where the aneurism has caused irritative and inflammatory changes. By some it is held that the transversalis fascia can always be stripped up along with the peritonæum. As this fascia is thickened and attached, close to Poupart's ligament, to form the deeper crural arch and front of the femoral sheath, it is very doubtful if it can ever be detached unless it is divided or torn through. The latter is very easy on an aged corpse.

§ So as to lie well above the origin of the deep epigastric, which usually comes off $\frac{1}{4}$ or $\frac{1}{2}$ inch above Poupart's ligament. The absence of any other branch should, if possible, be verified.

incision, adequate use of retractors, and light thrown in by a large mirror will usually allow the surgeon to see what he is doing. The effect of tightening the ligature being satisfactory, it is cut short and dropped in, the divided muscles are then brought together with buried gut sutures, sufficient drainage provided, and the superficial wound closed. The parts must be kept relaxed by propping the chest up slightly and flexing the knees over a pillow, but too much flexion of the groin is to be deprecated as causing a deep sulcus from which discharges will escape with difficulty. The limb

FIG. 145.



Ligature of the external iliac artery. The peritonæum is held out of the way above and at the two angles of the wound. Below are seen, from without inwards, the iliacus, psoas, genito-crural nerve, the artery (with a ligature beneath it), and the vein.

The incision below is that for ligature of the common femoral.

is evenly bandaged from the toes upwards, raised and kept covered in cotton-wool, with hot bottles placed in the bed.* In case of threatening gangrene, assistants should persevere in a trial of friction of the limb from below upwards. Where there is a history of syphilis, appropriate remedies should be given after the operation.

(2) INCISION OF ABERNETHY.—In his first operation this surgeon made his incision in the line of the artery for about 3 inches, commencing nearly 4 inches above Poupart's ligament. Later on

* If the patient be restless, as in delirium tremens, a long splint should be applied.

he modified his incision by making it less vertical and more curved, with its convexity downwards and outwards, and extending between the following points—viz., one about 1 inch internal and 1 inch above the anterior superior spine to $1\frac{1}{2}$ inch above and external to the centre of Poupart's ligament.

The respective advantages and disadvantages of the methods of Cooper and Abernethy appear to be the following: Cooper's is rather the easier, interfering, as it does with the peritonæum less, and lower down. It is most suitable to those cases which do not extend far, if at all, above Poupart's ligament. The risk of ventral hernia would appear to be less. On the other hand, where the extent to which the aneurism reaches upwards is not exactly known, Abernethy's operation, hitting off the artery, as it does, higher up, or some modification of that given (p. 606) for ligature of the common iliac will be found preferable.

Difficulties and Possible Mistakes.

(1) Too short an incision. Here, as in colotomy and other deep operations on the abdominal wall, every layer must be cut to the full extent of the superficial ones. Otherwise the operator will be working at the bottom of a conical, confined wound. (2) A wrongly placed incision—i.e., one which, by going too near the middle line, opens the internal abdominal ring, or which, if too low, may come too near the cord. (3) Disturbing the planes of cellular tissue needlessly or roughly. (4) Wounding the peritonæum, owing to a hasty incision through a thin abdominal wall, by rough use of a director, especially if the peritonæum is adherent in the neighbourhood of the sac, or fused with the transversalis fascia. The peritonæum is often difficult to distinguish; it is bluish in aspect, but of course not smooth, being covered with cellular tissue which connects it to the extra-peritonæal fat. (5) Stripping up the peritonæum roughly and too far. (6) Detaching the artery from the psoas. (7) Lacerating the psoas. (8) Tying or injuring the vein. (9) Including the genito-crural nerve. (10) An abnormal position of the artery. This may be due to an exaggeration of that naturally tortuous condition of the artery which is especially likely to be met with in patients advanced in life. Another unusual course of displacement may be met with in extravasated blood, when an aneurism has given way.

Sir W. Fergusson briefly reported (*Brit. Med. Journ.*, 1873, vol. i. p. 286) an instance of this kind, in which the sac gave way after repeated manipulation.

Causes of Failure and Death.

1. Gangrene. In some cases, where the limb does not become gangrenous, the vitality is very feeble and requires much attention.

Thus, in Mr. Rivington's case (*Clin. Soc. Trans.*, vol. xix. p. 45), loss of sensation was noticed on the fourth day, followed by paralysis of most of the muscles. Though gangrene did not appear, and the patient survived five and a half months, the limb was "on the verge of gangrene," as shown by sores appearing on the heel and great toe.*

* In one of Dr. Sheen's cases already referred to, four days after the operation

2. Secondary hæmorrhage. This is especially likely if the wound becomes septic and if catgut is used. This fatal result may be long deferred.

Thus, in Mr. Rivington's case (*loc. supra cit.*), the patient died of secondary hæmorrhage five and a half months after the operation; the wound had been found septic at the first dressing; a catgut ligature was used.

Early recurrence of pulsation may be ominous of secondary hæmorrhage.

In a case of Sir A. Cooper, the hæmorrhage which proved fatal a fortnight after the operation was found to be due to a large collateral—viz., an abnormal obturator arising immediately above the site of ligature (Roux, *Parallèle de la Chir. Anglaise avec la Chir. Française, &c.*, pp. 278, 279).

3. Cellulitis. Septicæmia. Pyæmia. Owing to the number of planes of cellular tissue met with here, any needless or rough disturbance of the parts, inadequate drainage, or a septic condition supervening are extremely to be deprecated. The wound should be opened up at once if any collection of fluid is suspected. 4. Peritonitis. 5. Tetanus, from including the genito-crural nerve. 6. Phlebitis and secondary hæmorrhage from injury to the external iliac vein. 7. Suppuration of the sac with its attendant dangers of septic infection and secondary hæmorrhage.* This accident is far from uncommon in cases of inguinal aneurism after ligature. No pains should be spared to prevent its occurrence by taking every step to keep the wound strictly aseptic from first to last, and thus to secure early and sound healing. Absolute rest should also be enforced upon the patient. If suppuration take place it will usually be within two months of the date of ligature. The symptoms need not be alluded to here beyond pointing out that pulsation is one of very grave omen. When it is evident that suppuration, if not established, is inevitable, the surgeon should so arrange his time as to choose a suitable occasion both as to assistance and a good light for interfering. Allowing the suppurating sac to open spontaneously should not be thought of, not only because of the risk of hæmorrhage, the want of preparation, &c., but because septic infection is now made very probable. The operative steps are much the same as in the old operation for aneurism, for which the reader is referred to p. 619. It may be here pointed out that in this case there is more chance of the hæmorrhage taking the form of a general oozing from the sac, and not that of a gush or spirt of blood. Moreover, if the collateral circulation has been well established, there is also the probability

a large patch of skin on the outer side of the thigh was noticed to be darkish in colour, and to pit on pressure, though normal as to sensation. The case did quite well.

* Very occasionally secondary hæmorrhage may take place to a slight amount, and leave off spontaneously. Thus, in one of Dr. Sheen's cases, five weeks after the operation "about an ounce of bright-red blood came from the slight remaining wound, and a slight oozing again after a few days, but there was no further hæmorrhage."

of the sac being fed by some additional branch, which, perhaps, entering deep down, may be a cause of much embarrassment.

8. Recurrence of pulsation. This is especially likely to occur when a catgut ligature has been used and given way, owing to its being softened by suppuration. Over-free collateral circulation will cause recurrence of pulsation quickly; and melting down of soft coagulum (this appearing to be all that the blood can do in the way of clotting) will bring about the same cause of failure later on. In these cases, the following courses are open in the matter of the external iliac—viz., well-adjusted and carefully maintained pressure and the old operation. Ligature of the vessel lower down—*i.e.* between the first and the aneurism—and amputation are not available here.* Two other conditions which may supervene and prove troublesome should be mentioned here—viz.: 9. Formation of a ventral hernia. This should be prevented as far as possible by ensuring primary union, and by the use of deep chromic-gut sutures in the cut muscles. Later on, if this complication threaten an appropriate belt should be worn. 10. Coming away of the ligature long after the operation through a persistent sinus or re-opened wound. This may happen, even in a wound kept sweet from first to last, if a silk ligature has not been properly sterilised, or if one of too close texture is used. See the footnote, p. 446.

LIGATURE OF THE COMMON ILIAC (Fig. 146).

Indications.—Very few:

1. Aneurisms. Especially those inguinal aneurisms which affect the external iliac in its upper part, above the origin of the deep epigastric, occupying the iliac fossa and lower part of the abdomen. When such aneurisms are progressing steadily, when they have resisted a trial of pressure, and are not thought amenable to the old operation, ligature of the common iliac is indicated.

The following remarks by one of the chief living authorities on aneurism, Mr. Holmes (R. C. S. Lectures (*Lancet*, 1873, vol. i. p. 297), will aid the surgeon in coming to a decision in this most important matter:

“Allowing that an iliac aneurism is amenable to all three methods of treatment—the Hunterian, by ligature of the aorta or common iliac; the old operation, by laying open the sac and securing the artery or arteries opening into and

* In one case (*Syd. Soc. Bien. Retr.*, 1873-4, p. 220) after ligature of the external iliac for a femoral aneurism with catgut, and premature absorption of this on the fifth day (the wound suppurated freely, and antiseptic precautions do not appear to have been taken), pulsation returned, and the swelling enlarged. The patient was operated upon again, and a stout carbolic hempen ligature made use of, one end being left long. Though, owing to the close matting of parts, the peritonæum was wounded twice, and intestines and omentum protruded, the patient recovered.

out of it; and the method of compression applied to the aorta or common iliac—I think no one could deny that the number of cures by the latter method bears a very large proportion to the number of cases treated, while the cures by the Hunterian method are very rare, and the other method is as yet pretty nearly untried.

“But this is far from settling the question; compression, doubtless, often succeeds, but it also often fails. It is not without its risks. It usually requires the prolonged use of chloroform, and this cannot always be borne by the patient.

“The question of applying the old method in preference to the Hunterian in those cases (rare, it may be, but which must sometimes be met with) in which pressure has failed, is one which Mr. Syme's brilliant operations have put in a totally new light. And, I must say, for my own part, that, looking at the awful mortality which has attended the ligature of the common iliac for aneurism, and the uniform fatality of the same operation on the aorta, I think Mr. Syme's suggestion ought to be put to the test of more extended experience, although the facts and reasonings which I have adduced will show that I am not insensible to the risks which attend the performance of the operation, to the probability of secondary hæmorrhage, and to the extensive injury which must be inflicted upon parts in the immediate neighbourhood of important organs.”

Mr. Holmes, then, in proof of the great fatality of the Hunterian operation on the common iliac, quotes the list collected by Dr. Stephen Smith (*Amer. Journ. Med. Sci.*, July 1860, vol. xl.), in which, out of fifteen cases in which that vessel was tied for aneurism, only three can be reckoned as definitely cured.

Mr. Holmes' belief that subsequent experience has not been more favourable is supported by a table of 65 cases, tabulated by Dr. Packard.* Of these 65 cases, no fewer than 51 died, only 14 recovering, giving a general mortality of 78.46 per cent.†

Mr. Holmes goes on to discuss the old operation, and, in answer to the objection that, though the Hunterian operation has been attended with “awful mortality” here, we are not made more secure by operating on an artery, perhaps not much more than 3 inches lower down, and already involved in disease, writes: “I reply that if we grant the artery where it is involved in the sac to be healthy enough to bear the ligature, many advantages may be found in the old operation over that of Hunter. . . . First, the clot is removed, and the sac laid open; consequently, that softening of clot and inflammation of a closed sac lying in proximity to the peritonæum, which is so surely fatal, is obviated. Next, the ligature will probably be placed on the external iliac instead of the common, and thus the chances of gangrene will be greatly diminished, since the internal iliac and its branches are left open. Thirdly, the artery is tied at a point where most likely the peritonæum and viscera have been pushed away from it by the sac, so that there is less risk of hurtful interference with these latter in the operation.

* *Trans. Amer. Surg. Assoc.*, vol. i. p. 234. Sixty-seven cases are given, but the result is not stated in two.

† Grouping these cases into classes, after Dr. Smith's example, in order to obtain more satisfactory deductions, Dr. Packard concludes as follows:—
(i) Those cases in which the operation was done for the arrest of hæmorrhage: 22 cases, of which 19 died and 3 recovered; mortality, 86.36 per cent. (ii) Those in which it was done for the cure of aneurism: 35 cases, of which 24 died and 9 recovered, the result not being stated in 2; mortality in 33 cases, 72.72 per cent. (iii) Those cases in which tumours simulating aneurism led to its performance: 5 cases, 4 of which died and 1 recovered. (iv) Those in which the vessel was secured to prevent hæmorrhage during the removal of a morbid growth: cases, all of which died.

And, lastly, the total excision of the tumour precludes any such relapse as occurs sometimes after the Hunterian operation.

"Against these advantages must be set the undoubted risks of secondary hæmorrhage, even in cases where the immediate dangers of the operation have been surmounted. What this risk is we have no means of judging until our experience of this operation becomes greater; but I am under the impression that Mr. Syme much underrated it, in consequence of having operated chiefly upon traumatic aneurism."

Farther on, Mr. Holmes writes, while "maintaining that the old doctrine on which the superiority of Hunter's operation is based is quite true in general, I should have no objection in the particular instance of iliac aneurism to follow Mr. Syme's practice; at least, until further experience of it should show that it is wrong: only the less dangerous expedient of rapid compression of the trunk artery under chloroform, or gradual compression, with or without chloroform, should first be tried."

The same authority, when, later on, discussing the value of pressure, brings out the following facts. That, while rapid compression under chloroform is a mode of treatment by which most gratifying success has been obtained in iliac as well as aortic aneurism, it exposes the patient to serious dangers. Amongst these are enteritis and peritonitis from bruising of small intestine, mesentery, meso-colon, and sympathetic; hæmaturia; failure of pulse and breathing when the pad is screwed down. On account of these very real dangers, which every dexterity may not obviate, Mr. Holmes advocates a trial of gradual compression, as safer, though less efficient, and he points out that the relations of the common iliac are less complicated than those of the aorta, and, "as we get further to one side, there is more chance for the intestines to slip out of the way."*

2. Wounds. These may be gunshot or bayonet wounds, or knife stabs of the vessel itself, or the internal iliac or its branches, usually the latter. The hæmorrhage calling for ligature seems to be usually secondary.† Gunshot wounds of the common iliac have a fresh interest now, owing to the recent advances in surgery in the treatment of gunshot wounds of the abdomen.

Dr. S. Smith‡ gives two cases of ligature of the common iliac for wounds:

One was from a musket-ball which injured the vessel itself, passed through the

* Mr. Holmes draws attention also to this most important point—i.e., that rapid coagulation in an aneurismal tumour cannot be regarded as in itself a means of cure, but only as the commencement of a process which, if not interrupted, may result in cure, and that thus, while pulsation may diminish soon after a trial of compression, it may not absolutely cease for quite a month.

† It would naturally be thought that hæmorrhage from a wound of the common iliac would be fatal before a ligature could be applied. Dr. Otis gives a case in which this vessel was wounded by a ball entering from the buttock through the sacro-iliac synchondrosis. Death took place from hæmorrhage on the second day.

‡ *Amer. Journ. Med. Sci.*, 1860, vol. xl. p. 17.

intestines, and lodged in the sacrum. The operation was performed by opening the peritonæal cavity. Peritonitis soon set in; secondary hæmorrhage recurred repeatedly, and the case ended fatally on the fifteenth day. The other case is of great interest, as the common and internal iliac were here tied for severe hæmorrhage after a stab in the inguinal region. A large quantity of blood was found in the peritonæal cavity, and the patient died ten hours after the operation. At the autopsy it was found that the deep epigastric was the wounded vessel.

Dr. Otis* records four cases of ligature of the common iliac during the American Civil War:

In one, a gunshot wound, in which the ball entered the groin and came out at the buttock, the external iliac was first tied, the repeated hæmorrhages being believed to be from the profunda, but as the bleeding persisted and evidently came from the sciatic, the wound was prolonged and the common iliac tied. Both ligatures came away, and the operation wound healed, but the patient died about three months later of exhaustion, associated, apparently, with necrosis in the gluteal region. In the second case the common iliac was tied for a gunshot wound believed to be of the gluteal artery, in which the hæmorrhage was not arrested by tying the internal iliac. The hæmorrhage recurred, and death took place two days later. The third case was one of diffuse aneurism of the right buttock and iliac fossa resulting from a bayonet-stab in the former region. Death took place four days later from gangrene of the sac. The old operation is considered by Dr. Otis to have been preferable in this case, but as the autopsy showed that the anterior trunk of the internal iliac had been wounded, within the sacro-sciatic notch, by the bayonet, it is difficult to see how the case could have been treated save by ligature of the internal iliac, either outside or within the peritonæum, and then by opening and filling the aneurismal sac with aseptic gauze or sponges. The fourth case was one of aneurismal varix of the femoral vessels from a punctured wound 2 inches below Poupart's ligament. In this case, owing to the impossibility of separating the peritonæum, this was incised and the common iliac thus secured. Peritonitis proved fatal four days later. Here ligature of the artery lower down, above and below the original seat of injury, would have been better treatment.

3. For the arrest of hæmorrhage apart from aneurism. Such cases may be met with after amputation near the hip, followed by secondary hæmorrhage from the branches of the internal iliac in what is usually the posterior flap.

Mr. Liston, *Lond. Med. Gaz.*, April 24, 1830, published a case of this kind in which, after amputation below the trochanter minor for necrosis of the femur, hæmorrhage occurred from the stump on the seventh day. As this could not be arrested, the common iliac was tied, but the patient died twenty-four hours later.

Dr. Packard (*loc. supra cit.*, foot-note, p. 601) treated a somewhat similar case in the same way, successfully.

This case is especially interesting, as the hæmorrhage occurred from branches of the internal iliac after a Furneaux Jordan's amputation, a method which is coming largely into vogue now, and which would usually be expected to do away with the above risk.† Hæmorrhage occurred from the stump on the sixth day, and as pressure failed the common iliac was tied. The patient ultimately did well.

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 333.

† In Dr. Packard's case the Furneaux Jordan's amputation was performed probably higher up than usual, owing to osteo-myelitis, after a previous amputation for growth, at about the middle of the thigh.

It will not, it is hoped, seem a hasty criticism on the above if I say that in future cases opening up the flaps and plugging with aseptic gauze,* or the application for some days of Spencer Wells' forceps, aided by even pressure on the flaps and pressure on the common or external iliac, would be preferable to submitting the patient here to the severe and risky operation of ligature of the common iliac.

4. For pulsating tumours simulating aneurism. As these growths from the iliac fossa and the walls of the pelvis have been found to be malignant, it is of the utmost importance to form a correct diagnosis in these cases, and thus save a patient who has a certainly fatal disorder from being submitted to an operation which is most dangerous, and almost certain to be useless.† As mistakes have, however, been made in these cases by excellent surgeons,‡ the chief points of diagnosis, as given by Mr. Holmes,§ may be briefly mentioned here: (1) The bruit is usually less well marked; (2) the pulsation is less heaving and less expansive; (3) The condition of the bone with which the swelling is connected; thus a plate of bone may be found in the supposed aneurismal sac; the supposed aneurism may be found both on the gluteal and the iliac aspects of the pelvis, the bone being expanded by the growth; (4) The cancerous cachexia is usually present, and perhaps secondary growths as well.

5. For hæmorrhage, not the result of a wound. Ligature of the common iliac has been employed in some cases of this nature, usually secondary hæmorrhage after ligature of the external iliac, the gluteal and sciatic, or after rupture of the external iliac. Ligature of the main trunk has been so fatal here that it should be abandoned, carefully applied pressure, aided by plugging with aseptic gauze, or the old operation, being certainly preferable.

Mr. Marrant Baker has put on record|| a case of great interest in diagnosis, in which an abscess from sacro-iliac disease ulcerated into branches of the internal iliac artery, and when opened gave rise to hæmorrhage calling for ligature of the common iliac:—A gardener, aged seventeen, had felt pain a month previously while digging. A tense, elastic swelling, distinctly fluctuating, and acutely tender, occupied all the right buttock. It was opened, and a small stream of apparently arterial blood escaped without jets. On further exploration

* The gauze within the wound being wrung out of turpentine if the parts are sloughy (p. 468).

† In Guthrie's case, a pulsating tumour in the right buttock, the size of an adult head, diminished by one-half in a month. Two months later it again enlarged, and the patient dying, eight months after the operation, an immense encephaloid tumour was found occupying the right iliac region.

‡ *E.g.*, Guthrie (*Lond. Med. Gaz.*, vol. ii. 1834); Stanley (*Med. Chir. Trans.*, vol. xxviii.); Moore (*ibid.*, vol. xxxv.).

§ *Syst. of Surg.*, vol. iii. pp. 44, 145. The reader should also consult Mr. Holmes' article, "On Pulsating Tumours which are not Aneurismal, and on Aneurisms which are not Pulsating Tumours" (*St. George's Hosp. Reports*, vol. vii.).

|| *St. Barthol. Hosp. Reps.*, vol. viii. p. 120.

the finger entered a large cavity between the iliac bone and the glutei. The iliac fossa was full and tense, and on examination, per rectum, a swelling was found in the right ischio-rectal fossa. On enlarging the gluteal wound a steady stream of arterial blood welled up through the great sacro-sciatic foramen. This was firmly plugged, and the common iliac tied. On removing the plug some bleeding still occurred, but was easily arrested. The gluteal wound became offensive, and this region, together with the upper part of the thigh, became gangrenous, the leg and foot remaining unaffected. The patient died forty hours after the operation.

At the autopsy the sacro-iliac joint was open with surrounding caries. The remains of a large abscess were found involving the branches of the internal iliac. There was no trace of aneurism.

6. Preparatory to the removal of caries of pelvis. Where, after amputation at the hip-joint, pelvic caries persists, leading steadily to lardaceous disease, I think an attempt should be made to remove all of the innominate bone which is diseased. Such profuse oozing follows that the common iliac should first be tied.

I adopted this course in a boy aged nine, seven years ago. The common iliac was most easily tied by the free anterior abdominal incision given below, and the pubic part of the bone removed the same day. A little later I removed the ischium and the acetabular portion of the ilium, leaving the upper half. Bronchitis increased, I fear, by the ether given at the second operation, carried off the child three weeks after ligature of the common iliac. The bleeding was slight and easily arrested, the chief difficulty met with here being the detachment of the soft parts in the neighbourhood of the pubes, tuber ischii, and sacro-iliac joint. The thickening of the pelvic fascia, present in these advanced cases, shuts off the contents of the pelvis.

Surgical Anatomy.—The common iliacs coming off on the left side of the fourth lumbar vertebra, incline downwards and outwards to divide, opposite to the lumbo-sacral intervertebral disc, into the internal and external iliacs. The right is rather the longer and more oblique of the two. Their length is usually $1\frac{1}{2}$ inch. Their branches are few and small—viz., to the ureter, psoas muscles, glands, &c. The iliacs become increasingly tortuous with age: a point of importance in tying the vessel on an aged corpse.

LINE.—One drawn from a point $1\frac{1}{2}$ inch below and a little to the left of the umbilicus to the centre of Poupart's ligament, the line curving a little outwards in its course, will represent the course of the artery with sufficient accuracy.

GUIDE.—The above line is the only surface guide: more deeply the lumbo-sacral articulation and the psoas muscles are useful guides, especially in a thin subject.*

RELATIONS:—

IN FRONT.

Peritonæum; small intestine; cæcum and appendix, sometimes.

Ureter.

Sympathetic.

* Attention has been drawn to the need of employing touch, as well as sight, in the ligature of these large trunks (p. 596).

OUTSIDE.

Psoas.
Vena cava.
Right common
iliac vein.

INSIDE.

Left common iliac vein.

Right common
iliac artery.

BEHIND.

Right and left common iliac vein.

IN FRONT.

Peritonæum ; small intestine.

Sympathetic.

Ureter.

Superior hæmorrhoidal artery. End of ileum.

OUTSIDE.

Psoas.

Left common
iliac artery.

BEHIND.

Left common iliac vein.

Collateral Circulation.—The chief vessels are :—

ABOVE.

BELOW.

Internal mammary and
lower intercostals,
Lumbar,

with
with

Deep epigastric.
Ilio-lumbar and circumflex
iliac.
Lateral sacral.
Inferior and middle hæmor-
rhoidal.

Middle sacral,
Superior hæmorrhoidal,

with
with

In addition, the pubic arteries anastomose behind the symphysis.

Operations (Fig. 146).—The common iliac may be tied by operations based upon one of three incisions. (1) An anterior abdominal, by which the vessel is approached more directly from the front; an incision based upon those for tying the external iliac, and made use of by Dr. Mott, of New York, who first tied this vessel for aneurism in 1827. (2) A posterior abdominal, or loin incision, by which the vessel is reached from behind; a method made use of by Sir P. Crampton, of Dublin, in 1828, and by Mr. Stanley at St. Bartholomew's, in 1846 (Fig. 146).

(1) *Anterior Abdominal Incision.*—The preparatory treatment is here the same as that for the external iliac. The parts being shaved and cleansed, a curved incision, 5 to 8 inches long, according to the amount of fat, the development of the body, and the size of the aneurism, is made, commencing just outside the centre of Poupart's ligament and $1\frac{1}{2}$ inch above it, then carried outwards, reaching towards the crest of the ilium, then upwards towards the ribs, and finally curving inwards towards the umbilicus, till sufficiently free to admit of the necessary manipulations

for reaching the artery. The three abdominal muscles are cut through, either on a director, or with careful, light sweeps of the knife, till the fascia transversalis is reached; any vessels which bleed * being at once secured with Spencer Wells' forceps. The fascia transversalis, which may generally be known from the peritonæum by the layer of extra-peritonæal fat, which usually intervenes between the two, is then picked up and divided on a director, at the lower part of the wound where it is best marked.† The peritonæum is next raised upwards and inwards, first one finger, and then more, being insinuated towards the middle line until the psoas is reached. On the inner side of this muscle the artery will be found, the external iliac being traced up if needful. In order to aid the surgeon in the difficulties which are now met with, owing to the artery lying at the bottom of a very deep wound, the abdominal walls should be relaxed by bending up the thighs, the wound sponged thoroughly dry, and light thrown in by a reflector or electric lamp. Care will, of course, have been taken to divide every layer from end to end equally, and thus to avoid a conical hole of a wound. The position of the vessel having been made out, it is to be cleaned with a director, especial care being taken on the right side, as here both the common iliac veins lie behind the artery. The needle should be passed from within outwards.

(2) *Posterior Incision, partly in Abdomen, partly in Loin.*—This operation will be best given in the words of Sir P. Crampton,‡ who first introduced it:

"The first incision§ commenced at the anterior extremity of the last false rib, proceeding directly downwards to the ilium; it followed the line of the crista ilii, keeping a very little within its inner margin, until it terminated at the superior anterior spinous process of that bone; the incision was therefore chiefly curvilinear, the concavity looking towards the navel. The abdominal muscles were then divided to the extent of about an inch, close to the superior anterior spinous process, down to the peritonæum; into this wound the forefinger of the left hand was introduced, and passed slowly and cautiously along the line of the crista ilii, separating the peritonæum from the fascia iliaca. A probe-pointed bistoury was now passed along the finger to its extremity, and by raising the heel of the knife, while its point rested firmly at the end of the finger as on a fulcrum, the abdominal muscles were separated from their attachments to the crista ilii by a single stroke. By repeating this manœuvre the wound was prolonged until sufficient room was obtained to pass down the hand between the peritonæum and the fascia iliaca. Detaching the very slight connections which these parts have with each other, I was able to raise up the peritonæal sac, with its contained intestines, on the palm of my hand from the psoas magnus and iliacus internus muscles, and thus obtain a distinct view of all the important parts beneath; and assuredly a more striking view has seldom been presented to the eye of the surgeon; the parts were unobscured by a single drop of blood:

* See note, p. 596.

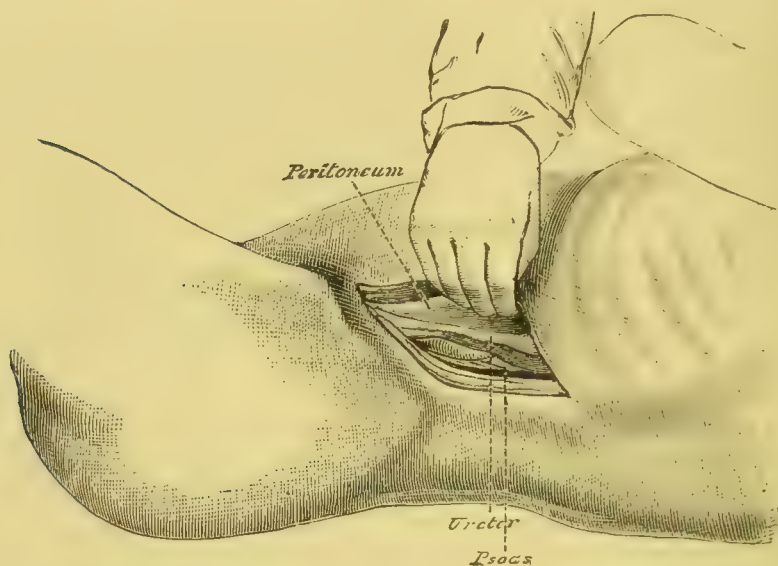
† Dr. Liddell (*Intern. Encycl. of Surg.*, vol. iii. p. 312) recommends that the separation of this fascia from the peritonæum should be begun at the upper part of the wound, where the adhesion is slightest.

‡ *Med. Chir. Trans.*, vol. xvi. p. 161.

§ The patient would, of course, be rolled over on to the sound side.

there lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish-white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size, the ureter in its course to the bladder lay like a white tape across the artery, but in the process of separating the peritonæum, it was raised from it with that membrane, to which it remained attached. The fulness of the iliac vein seemed to vary from time to time, now appearing to rise above the level of the artery, and now to subside below it. Nothing could be more easy than to pass a ligature round an artery so situated. The forefinger of the left hand was passed under the artery, which, with a little management, was easily separated from the vein; and on the finger (which served as a guide) a common-eyed probe, furnished with a ligature of moistened catgut, was passed under the vessel. A surgeon's knot was made in the ligature, and the noose gradually closed, until Mr. Colles, who held his hand pressed upon the tumour, announced that all pulsation had ceased.

FIG. 146.



Ligature of common iliac by a posterior incision. This would also be available for the abdominal aorta. (Bryant.)

A second knot was then made, and one end of the ligature cut off short." Unfortunately, the catgut of that day became quickly dissolved, pulsation returned in the tumour within fifty hours of the operation, and on the tenth day profuse secondary hæmorrhage took place, death following immediately.

Comparison of the Two Methods.—Sir P. Crampton thus speaks of his own and Dr. Mott's operation: "The operation of tying the common iliac artery is not only a feasible but (when performed in the manner described in this paper) an exceedingly easy operation. The difficulties which Dr. Mott encountered, and which prolonged the operation to nearly an hour,* are clearly referable to the circumstance of his incision having been made too low. This, in the first place, brought him in contact with the aneurismal tumour, from which he was obliged, with great labour and considerable risk, to detach the peritonæum; then he had the whole mass of the

* Sir P. Crampton's operation was completed in twenty-two minutes.

tumour between him and the artery which he was to tie ; and lastly, he had the intestines pressing down upon him and producing such a complication of difficulties as I believe few men but himself could have encountered with success."

Mr. Skey (*Operative Surgery*, p. 294) preferred the posterior incision for these reasons: (1) It is a part less liable to consequent inflammation. (2) The requisite separation of the peritonæum is less extensive. (3) The artery is brought better into view, the act of passing the needle round it being made visible to observers around. (4) The line of the vessel is sufficiently exposed to enable the operator to select his site of ligature, to carry it either higher or lower, or even, if necessary, to separate the peritonæum from the aorta itself, and to pass a ligature around that vessel at a sufficient distance from its bifurcation. (5) The formation of a ventral hernia is not likely to occur.

To the above Mr. Skey might have added that the posterior incision gives far better drainage to the wound.

The difficulties of the operation and the causes of failure and of death are much the same as those already given in the account of ligature of the external iliac (pp. 598-600).

(3) *Intra-peritonæal Method*.—See page 612.

LIGATURE OF THE INTERNAL ILIAC.

Indications.—Very few and rare.

i. In some cases of gluteal and sciatic aneurisms. Mr. Holmes in the course of those lectures from which I have already quoted, lays down conclusions which will very greatly help the surgeon in deciding what form of treatment is best suited to these aneurisms. They are quoted below under the heading of Ligature of the Gluteal Artery (p. 617).

ii. Hæmorrhage. This is most frequently met with in military surgery after gun-shot wounds of the vessel itself, but more often of one or more of its branches within the pelvis, the ball entering usually from the front through the inguinal region or behind through the sacrum.

Four such cases are given by Dr. Otis,* all being fatal. Two cases, in which this artery was tied for wounds of the sciatic and gluteal respectively, are given by the above writer (p. 332) ; both were fatal from hæmorrhage.

Dr. Liddell,† who, as U.S.A. Medical Inspector, saw much of military surgery, gives the following advice in cases of punctured wounds of this artery or its branches: "The wound should be explored by introducing the finger into it for the purpose of locating by touch the precise point whence the blood issues by jets into the wound. If the punctured artery is found to be external to the pelvis, the bleeding point should be laid bare by enlarging and

* *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 331.

† *Intern. Encycl. of Surg.*, vol. iii. p. 125.

cleansing the wound, and the vessel secured by ligatures placed on each side of the aperture. But if it be shown by the occurrence of intra-pelvic extravasation of blood, or by other signs, that the internal iliac artery, or some branch thereof, is wounded within the pelvis, it will be impossible to reach and tie the punctured artery, in the wound. Under these circumstances it sometimes becomes very difficult to decide what plan of treatment should be adopted. . . . One thing," Dr. Liddell goes on to say, "ought never to be done, that is, trusting to the use of iron perchloride or persulphate.* The first thing to be tried, in most cases, is compression. It should be applied to the common iliac artery, and, at the same time, to the wound itself, if possible, with a view to obtain coagulation of the blood in, and obliteration of, the wounded artery. The very desperateness of these cases makes it all the more necessary to use the compression faithfully, intelligently, and persistently, otherwise a traumatic aneurism will form." Nowadays, laparotomy will very likely be resorted to (p. 612).

iii. To bring about atrophy of the enlarged senile prostate.

Dr. Bier, first assistant to Prof. von Esmarch of Kiel, was the first to tie the internal iliacs for the above purpose (*Wien. Klin. Woch.*, No. 32, Aug. 10, 1893).

He did this in three cases, in one intra-peritonæally, and in two, extra-peritonæally. The latter two made good recoveries. In the first case the way in which the anæsthetic was taken caused so much trouble that, Trendelenberg's position failing, it was found needful to withdraw a large part of the small intestine, in order to reach the arteries. This patient died of septic peritonitis on the third day.

Dr. W. Meyer (*Ann. of Surg.*, July 1894) publishes a case treated by Bier's method.

The patient was fifty-five, and very stout. For six months he had been unable to pass any urine, having to rely on a catheter altogether. The prostate was generally enlarged, its upper border could only just be reached *per rectum*. The extra-peritonæal method was adopted. The left artery was taken first. An incision, slightly concave inwards, and five inches long, was made parallel with the upper third of Poupart's ligament and running up towards the tip of the eleventh rib. The common and internal iliacs were reached without much trouble. The artery was tied with catgut, but the vessel having been punctured when the sheath was divided, two ligatures were applied on either side of the puncture, and the artery was divided between them. The ligature on the proximal end slipped off, and further attempts to place a ligature proving futile, a long pair of artery forceps was placed on each divided end, and left *in situ*, being carefully packed around with gauze. The right internal iliac was then tied with a double catgut ligature, but the vessel was not divided. The two forceps were removed on the fifth day, no hæmorrhage following. On the twelfth day arterial hæmorrhage took place from the track of the forceps on the left side. On opening up the wound it was found that the bleeding came from an opening in the external iliac, due to the pressure of the forceps where it crossed this vessel. Pressure being made on the common iliac, the external was tied above and below the perforation, and then the common iliac was tied also, silk being used on this

* See the remarks, p. 468.

occasion. Partial gangrene of the foot followed, necessitating an irregular amputation of its anterior part. The influence of tying both internal iliacs in the enlarged prostate in this interesting case was as follows: Twelve hours after the operation the patient began to pass his water (20 ounces) in a fine stream for the first time for six months. This improvement slowly increased, though it was evident that there was marked atony of the bladder. The patient gained sufficient power to hold his water two, or even three or four hours, and then to pass ten or twelve ounces, in a forcible stream. The residual urine remained considerable, 10 ounces or more. The prostate became almost normal in size, and the length of the urethra became reduced from $23\frac{1}{2}$ to $21\frac{1}{2}$ cm., the length of a normal urethra being 21 cm.

Dr. Meyer also operated according to this plan on a man, aged sixty-three, with retention due to hypertrophy of the prostate. A single silk ligature was easily placed around each artery within its sheath, and tied. The wound healed without reaction. The patient voided his urine in a fine forcible stream several times during the night after the operation. Retention did not again set in. On the fifth day after the operation the temperature became subnormal without apparent cause, and the patient died comatose three days later. Only a very limited autopsy was permitted, and there is no account of the state of the kidneys.

We have seen that the two cases in which Dr. Bier operated by the extra-peritoneal method recovered. Neither, before the operation, had been able to pass a drop of urine. Spontaneous power returned in each case, and improved progressively, one of the patients stating, four months later, that he could micturate as well as ever before.

Surgical Anatomy.—A short trunk, about $1\frac{1}{2}$ inch long, of large size, the internal iliac, given off opposite to the lumbo-sacral intervertebral disc, dips downwards and backwards as far as the upper part of the sacro-sciatic notch, where it gives off its anterior and posterior trunks, a ligamentous cord also coming off from the bifurcation: this cord, the remains of the obliterated hypogastric artery, usually remains pervious as far as the bladder as one of the vesical arteries.

LINE.—No distinct line or guide can be given for this vessel owing to its at once dipping into the pelvis, but it will be worth while to remember that a line drawn with a slight curve outwards from a point about an inch below, and a little to the left of, the umbilicus, to the centre of Poupart's ligament, gives sufficiently accurately the line of the common and external iliac arteries: the internal is given off about two inches from the commencement of this line.*

RELATIONS:—

IN FRONT.

Ureter.

Peritonæum.

Rectum (left side).

OUTSIDE.

Right internal iliac vein.

Obturator nerve.

Internal iliac.

INSIDE.

Pyriformis.

Sacral nerves.

* The origin of the arteries will be found nearly opposite to the centre of a line drawn from the anterior superior spine to the umbilicus.

BEHIND.

Internal iliac vein.
Sacro-iliac synchondrosis.
Lumbo-sacral cord.

Collateral Circulation.

Sciatic	with	Superior branches of profunda.
Hæmorrhoidal branches	„	Inferior mesenteric.
Pubic branch of obturator	„	Vessel of opposite side.
Branches of pudic	„	Branches of opposite vessel.
Circumflex and perforating of profunda	„	Sciatic and gluteal.
Lateral sacral	„	Middle sacral.
Circumflex iliac	„	Ilio-lumbar and gluteal.

Operation.—The preparatory treatment being the same as in ligature of the external iliac (p. 595), the surgeon makes an incision much as in the case of the common iliac, or else, in the words of Dr. Stevens (who first tied the vessel successfully in 1812) “one about 5 inches long, parallel with the deep epigastric artery, and nearly $\frac{1}{2}$ inch on the outer side of it.” The peritonæum having been raised up, the hips are well flexed and the lips of the wound retracted as widely as possible: the finger now finds the external iliac, and then, by tracing it up, the internal iliac vessel.* The cord of the obturator nerve must not be mistaken for this.†

The artery is now separated, partly with the finger-nail and partly with the point of the director, and the needle passed from within outwards, avoiding the vein and psoas muscle. The ureter usually crosses the artery at its commencement, and will be out of harm’s way. It will be well to have in readiness aneurism-needles of different curves, and an ordinary silver-eyed probe.

Ligature of the Internal and other Iliacs by Abdominal Section.—This method has been advocated recently by Dr. Dennis,‡ of New York, on account of the following advantages:—(1) Abdominal section in no way increases the dangers of the operation of ligature of the internal iliac. (2) This method prevents a series of accidents which have occurred during the performance of the operation of ligature of this artery by the older methods. Amongst these are, the division of the circumflex and epigastric arteries, wounding the vas deferens, including the ureter in the ligature, puncturing the iliac or circumflex veins, tying the genital branch of the

* The finger should be passed downwards and backwards towards the sacro-iliac synchondrosis.

† In cases of doubt the artery should be compressed gently between the finger and thumb.

‡ *New York Med. News*, November 20, 1886; *Annals of Surgery*, vol. v. No. 1, p. 55. I am indebted to the latter periodical for the above account.

genito-crural, tearing the peritonæum, injury to the sub-peritonæal connective tissue, cellulitis. (3) Abdominal section enables the surgeon to apply the ligature at a point of election, and to obtain information as to the exact extent of the disease in the main arterial trunk. (4) Securing the internal iliac by this method takes much less time than was occupied by the older ones.

Three cases are given by Dr. Dennis, two of which occurred in his own practice.

I. A woman, aged sixty, presented pulsatile tumours in both gluteal regions, the tumours dating back a year and a half, and pain three years back. The external parts being thoroughly purified, a median incision was made from the umbilicus to the pubes; the small intestines, which would have hindered the operation, were drawn out into warm, moist sponges and towels, the internal iliacs of both sides ligatured with catgut, the viscera returned, the wound closed, and aseptic dressing supplied. The patient died with suppression of urine, and slight parenchymatous nephritis, on the third day. II. A negro, aged forty-six, had a right gluteal aneurism, the trouble dating back seven months. By a curved lateral incision the abdomen was opened; owing to the violent efforts of the patient, and the difficulty of manipulation, a few coils of intestine were drawn out, a strong silk ligature applied to the internal iliac, the parts cleansed, and the wound closed. A cure followed. III. A female, aged eighteen, had an aneurismal varix of the left side, the trouble dating back many years. Under careful antiseptic treatment the abdomen was opened, the incision finally extending from the symphysis to some distance above the umbilicus, the intestines drawn out sufficiently to admit of exposure of the vessel, a double twisted catgut ligature applied to the left internal iliac, the bowels returned, and the wound treated as before. The patient rallied quickly, and the bowels were moved normally on the fifth day: a slight acute albuminuria, due to congestion of the kidney from the ligature of the main trunk of the internal iliac, appeared on the following day, but soon disappeared. The aneurism, together with the aneurismal varix, was perfectly cured.

A few cases in which the iliac arteries have been tied intra-peritonæally in this country, are on record. One of the most interesting of these is fully recorded by Mr. Makins (*Lancet*, vol. ii. 1892, p. 1328).

The patient, aged thirty, had an inguinal aneurism, about two inches in breadth, extending upwards about two-fifths of the distance between the middle of Poupart's ligament and the umbilicus, and for about two inches below the ligament. An incision four inches long was made in the left linea semilunaris, the deep epigastric which originated in the swelling was tied between two ligatures. The small intestines were held over to the right with Messrs. Ballance and Edmunds' broad abdominal retractor, the sigmoid flexure was pushed upwards, and an incision made through the lower part of its mesentery and the peritonæum at the margin of the pelvis in the course of the external iliac. The wound was deep, there being about $1\frac{1}{2}$ inch of subcutaneous fat, and abundance of fat in the sub-peritonæal tissue, both beneath the anterior abdominal wall and around the vessel. This, together with some retching, rendered the freeing of the artery and the passage of the ligature a process of some difficulty. The spermatic vessels were also exposed and swelled up considerably in the wound. The artery was secured about $\frac{3}{4}$ inch below the bifurcation of the common iliac and $1\frac{1}{2}$ inch above the sac. Two threads of stout flossy sterilised silk were tied separately, but in close apposition, and with sufficient firmness to rupture the internal and middle coats. The posterior peritonæum was sutured over the artery. The

patient left the hospital, with the aneurism hard, painless, and shrinking, on the forty-seventh day.

The following remarks from Mr. Makins, well known not only as a surgeon but also as an anatomist, I quote verbatim :

“The reason for selection of the intra-peritonæal method in this case was the high position of the aneurism. Before operation the pulsation in the iliac fossa was so forcible and extensive that it seemed probable that it might prove necessary to ligature the common iliac, and it was thought that this would be more readily performed by the intra-peritonæal method. Beyond this the intra-peritonæal method seemed to offer the great advantage of not in the least interfering with the coverings of the sac, which, by the ordinary method, might have been disturbed by the stripping of the peritonæum. The experience gained by the operation showed that the usual method might have been safely adopted, but this could not be definitely determined beforehand. An advantage was gained in ready access to the deep epigastric artery, which, as directly feeding the sac itself, needed ligature, but, of course, might readily have been secured by an extension of the ordinary wound. As to the comparative difficulty of the two operations I think there is little to choose, and on the whole the incision for the extra-peritonæal method is perhaps to be preferred in the matter of cicatrix ; in the vertical incision the advantage of suturing the fibrous structures in the linea semilunaris is gained ; but, on the other hand, the resulting cicatrix passes directly through from skin to peritonæum. In the oblique incision the decussation of the various muscular layers leads to a certain intricacy and irregularity in the line of the cicatrix which may render it the stronger, since pressure is less readily brought to bear directly upon it. The choice of the iliac vessels obtained is, I think, a real advantage, since the incision needs neither extension nor modification ; but in saying this it should be pointed out that this is a much stronger argument on the right than on the left side of the body. Ligature of the right common iliac artery by the intra-peritonæal method is probably the easiest of all the operations on the great arteries, since the vessel lies directly beneath the peritonæum of the posterior abdominal wall, uncovered by any structure of importance. On the left side, on the other hand, the inferior mesenteric vessels as they enter the sigmoid mesocolon and pass down to the mesorectum, cover practically the whole of the artery, and to reach the common iliac comfortably and safely the peritonæum would need to be divided close to the left of the median line of the sacrum and displaced outwards. This manœuvre has the disadvantage of exposing the vein freely, but this would probably give far less trouble than the numerous mesenteric vessels would when swollen by reason of the loss of their peritonæal support. In the case recorded above the distension of the spermatic vessels when set free by the division of the peritonæum, was much greater than would have been expected.”

This most instructive case possesses the additional and especial interest that the patient developed a similar aneurism on the right side a few months later (*Lancet*, vol. ii. 1893, p. 196).

On May 3, 1893, Mr. Makins tied the right external iliac intra-peritonæally. An incision, commencing one inch below the level of the umbilicus and four inches long was made in the right linea semilunaris. The abdomen being opened, the small intestine was packed away with two small sponges and the posterior wall exposed. The artery was then seen below the termination of the ileum, crossed by the spermatic vessels. The aneurismal sac was about $1\frac{1}{2}$ inch in diameter. The peritonæum over the artery being divided, the vessel was ligatured with two strands of floss silk, tied with separate reef-knots, and then the peritonæum sutured over the artery. The patient was kept in bed for two weeks, and went out on the thirty-eighth day, having made an excellent recovery. A firm linear

scar was present in the left linea semilunaris, and two small, hard swellings marked the site of the cured aneurisms. Mr. Makins stated that he repeated the trans-peritoneal method here, because the first had proved so successful, and because the aneurism, though small, was situated entirely above Poupart's ligament. The operation on the right side proved much easier than that on the left, since the crossing of the ileum was on a higher level than was the case with the sigmoid mesocolon. The artery also was much more prominent on the brim of the pelvis. The circulation was re-established much more rapidly and satisfactorily after the second than after the first operation. On the first occasion the limb was very cold, and the patient suffered much neuralgic pain. On the second the local temperature fell little, if at all, and the patient had no pain. On the first occasion the deep epigastric was tied, a step not taken on the second, but Mr. Makins was inclined to think that the rapid re-establishment of the circulation was rather dependent on the enlargement of the branches of the internal iliac on the opposite side resulting from the obstruction of the first external iliac artery.

The two following cases in which abdominal section was resorted to for ligature of the external iliac show a striking contrast in the difficulties which may be met with :

In Mr. Mitchell-Banks' case (*Brit. Med. Journ.*, vol. ii. 1892, p. 1163), the patient, aged sixty-two, had an ilio-femoral aneurism as big as a fist occupying the upper part of the right Scarpa's triangle, pushing its way up beneath Poupart's ligament. On Sept. 20, 1892, the abdominal cavity was opened by an incision about three inches long in the right linea semilunaris. The cæcum and small intestines which came into view were held apart by the hands of an assistant. The position of the external iliac being readily detected, the artery was tied with catgut, and sufficient pressure being used to stop the pulsation in the aneurism and no more, no attempt being made to divide the internal coat. The incision in the peritonæum immediately over the artery was stitched up with fine catgut, so as to make the artery and ligature once more extra-peritonæal. The patient's recovery was uninterruptedly successful, save for one incident. On the eleventh day the sudden onset of acute præcordial pain and cyanosis, dyspnoea and collapse were thought to point to detachment of some bit of clot from the neighbourhood of the ligature. These complications gradually disappeared. For some time the aneurism contained fluid at one part, but gradually contracted, and the patient went out on the forty-second day after the operation.

Mr. Banks states that he made use of the abdominal section here because the aneurism pushed well up beneath Poupart's ligament, and he could not make out with certainty what was the condition of the artery above it.

The second case, under the care of Mr. W. H. Brown, of Leeds, tells a very different story of the difficulties which may attend ligature of the external iliac by abdominal section.

The patient, a woman, aged forty-eight, was admitted into the Leeds General Infirmary with two femoral aneurisms. The upper one, the size of a large coconut, occupied the right groin extending upwards above Poupart's ligament ; the second, a smaller one, occupied the middle third of the same right femoral vessel. The skin over the upper swelling was dark, very thin, and threatening to give way. The position of the upper aneurism was thought to preclude any of the usual operations, and it was decided to tie the external iliac intra-peritonæally, by a median incision. The abdomen was opened by an incision at first four and later six inches long, owing to the great amount of fat in the abdominal wall. The omentum was also very thick and greatly embarrassed manipulation. It was only after the pelvis had been well raised and emptied of the small intestines that a view could be obtained of the vessel. Mr. Brown states that he had the

greatest difficulty in obtaining, first of all, a view of the vessel, secondly, in passing the ligature. So far as the abdominal conditions were concerned the patient made a good recovery, but the foot and leg becoming gangrenous, amputation of the thigh became necessary. The patient sank about ten weeks after the ligature of the artery.

Mr. Wherry (*Lancet*, vol. ii. 1893, p. 136) made use of the intra-peritonæal method for ligature of the left internal iliac in a case of large pulsating sarcoma of the upper, outer, and back part of the innominate bone. The swelling was too large and vascular to admit of its removal safely.

"An incision was made from below the umbilicus to the pubes. There were two difficulties. Firstly, the vein, which was very large and much in the way, was swollen by the slightest pressure of sponges or retractors upon the upper part. The external or common iliac would have been much easier to tie in this case. There was some venous bleeding which stopped after the artery was tied, but the vein also was tied by a ligature just below the first one to make it safe. The other difficulty was with the light. Large reflecting refractors were of the greatest use, but an electric light would have been better still." The patient made a good recovery. The swelling at once shrank and ceased to pulsate, and the relief to pain and other distressing symptoms was very great, but no further result is given.

Mr. Treves (*Operative Surgery*, vol. i. p. 213) made use of this method in a boy, aged sixteen, with a vascular tumour of the buttock, in November 1889. He employed an incision from the umbilicus to the pubes, and kept the intestines packed up and aside with six sponges.

The following is Mr. Treves' opinion of the merits of the operation (*loc. supra cit.*, p. 211), and he is inclined to extend this method to the common iliac also. "The advantages of this method are obvious. The vessel is easily and fully exposed, and the needle can be passed without risk to the vein or ureter. The operation is simple, and involves but little time. Its dangers are, comparatively speaking, very few. The ligature can be applied accurately at the spot determined upon. The condition of the artery and the surrounding parts can be made out, and a diagnosis confirmed or modified. The great objection that some few years ago would have been urged against the procedure—the risk of acute peritonitis—may be at the present day almost disregarded."

Writing as I do for those whose operative experience is not to be compared with that of Mr. Treves, I hesitate to endorse the above opinion in its entirety. I am of opinion that with the above incision the intestines will sometimes give great trouble. A good deal of handling and exposure will be inevitable, and we all know that where the above are entailed, septic peritonitis does still, in spite of the advantages of modern surgery, tend to appear. In fairness I must add that I have only tied the iliac vessels once, the common iliac in the case mentioned at p. 605. The free incision there made use of (p. 606) would have rendered the securing of the internal iliac as easy as it did that of the parent trunk. In gun-shot injuries or stabs, the intra-peritonæal method will, of course, be made use of. My readers should refer to Mr. Makins' opinion on the intra-peritonæal method, quoted at p. 614.

LIGATURE OF THE GLUTEAL ARTERY.

Indications.

1. Stab. 2. Aneurism. 3. Hæmorrhage after opening an abscess. All are rare, especially the last.

1. Stab.—The source of the bleeding from a stab in the buttock may be very difficult to tell exactly. The surgeon must be guided by the position of the exit of the gluteal and sciatic vessels (Fig. 147); he will remember the outline of the gluteus maximus, the lower border of this muscle forming the fold of the buttock, the upper starting from the crest about two inches in front of the posterior superior spine, and running downwards and forwards to the great trochanter. Hæmorrhage from a stab in the upper part of this muscle will probably come from the gluteal; if from the lower part, from the gluteal or sciatic.

2. Aneurism.—This affection is so rare that it will be sufficient to quote the following conclusions of Mr. Holmes: *

(1) "Gluteal aneurisms, both traumatic and spontaneous, are very favourably circumstanced for the treatment by either rapid or gradual compression applied to the aorta or common iliac."

Mr. Holmes points out that gluteal aneurism, if not ruptured, is usually of no great size, and does not encroach upon the abdomen, and thus any part of the common iliac or aorta is accessible to pressure.

(2) "If this treatment, with or without anæsthetics, does not succeed by itself, it may be supplemented by coagulating injection or galvano-puncture, while the patient is narcotised, and the circulation commanded." Of the two, Mr. Holmes prefers galvano-puncture.†

(3) "When such treatment fails, and particularly in aneurisms with imperfect or ruptured sacs, where it is not indicated, the internal iliac must be tied when the surgeon thinks that he cannot find the artery outside the pelvis. But when the artery is accessible, the old operation, or the operation of Anel, should be practised, according to the size and extent of the tumour."

In deciding whether the aneurism is inside or outside the pelvis, the surgeon will see if the pulsation can be commanded by pressure on the artery above the aneurism, whether the latter can be lifted from the bone, and will also make an examination by vagina or rectum.‡

The old operation must always be formidable, and while modern tourniquets may admit of efficient pressure, there is always the risk of fatal hæmorrhage from the artery having retracted into the pelvis.

* Hunt. Lect., *Lancet*, 1874, vol. ii. p. 76; *Syst. of Surg.*, vol. iii. p. 148.

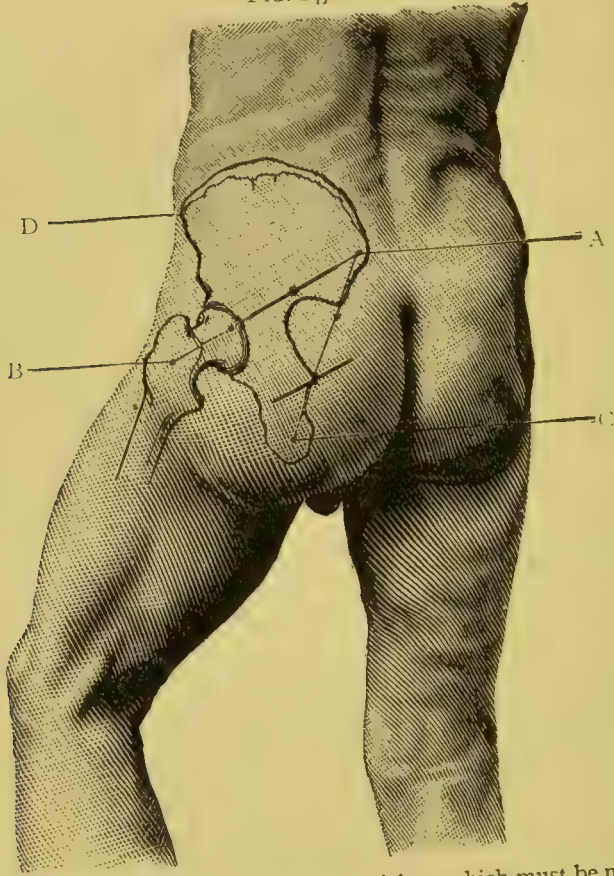
† See the remarks on the introduction of foreign bodies and galvano-puncture, pp. 541, 543, 620.

‡ An anæsthetic being given, and the hand passed here, if needful.

The method of Anel does not seem likely to be often useful: of three cases, one only has been successful.

(4) "The ligature of the internal iliac is liable to failure in cases of spontaneous aneurism from a diseased condition of the

FIG. 147.



Position and direction of the superficial incisions which must be made to secure the gluteal, sciatic, or pudic arteries.

A. Posterior superior iliac spine.

C. Tuberosity of ischium.

B. Great trochanter.

D. Anterior superior iliac spine.

AB. Ilio-trochanteric line, divided into thirds. This line corresponds in direction with the line of the fibres of the gluteus maximus. The incision to reach the gluteal artery is indicated by the darker portion of the line. Its centre is at the junction of the upper and middle thirds of the ilio-trochanteric line, and exactly corresponds with the point of emergence of the gluteal artery from the great sciatic notch.

AC. Ilio-ischiatic line. The incision to reach the sciatic or internal pudic arteries is indicated by the lower dark line. It is also to be made in the direction of the fibres of the gluteus maximus. The centre of the wound corresponds to the junction of the lower and middle thirds of the ilio-ischiatic line. (MacCormac.)

coats of the artery, and should always be avoided when other means of treatment are available."

This method has proved fatal in about half the cases operated on. The varying length of the artery, the proximity of the ligature in all cases to large branches and to the sac, have all to be remembered.

Here also ligature of the artery by laparotomy will probably be resorted to in the future (p. 612).

Surgical Anatomy of Gluteal Artery.—A short, thick branch from the posterior division of the internal iliac, this leaves the pelvis above the pyriformis, through the sacro-sciatic notch. Immediately after its exit it divides into a superficial and deep portion. The superficial is mainly distributed to the gluteus maximus; the deep lies between the gluteus medius and minimus, and divides into two, the upper branch running along the origin of the gluteus minimus, and the lower running obliquely across this muscle towards the trochanter major. The gluteal nerve emerges just below its artery, and sends branches with the deeper portion.

LINE AND GUIDE.—"If a line be drawn from the posterior superior spine to the great trochanter, the limb being slightly flexed and rotated inwards, the point of emergence of the gluteal artery from the upper part of the sciatic notch will correspond with the junction of the upper with the middle third of this line." (MacCormac, *Lig. of Arts.*, p. 126, figs. 10, 11.)

Operation (Fig. 147).—The patient being rolled two-thirds over on to his face, the part well exposed and cleansed, the limb hanging over the edge of the table, an incision, 5 inches long, is made in a line running from the posterior superior spine to the upper and inner part of the great trochanter. The incision should run almost parallel with the gluteus maximus. The fibres of this muscle being separated, between adjacent fasciculi, with a director, a muscular branch should be found and traced down to the exit of the artery. The gluteus maximus having been relaxed, and the contiguous margins of the gluteus medius and pyriformis separated with retractors, the surgeon, taking as his guide the above line and the aperture of the great sacro-sciatic notch, clears the artery as high up as possible, avoiding the nerve and the veins, and dividing the adjacent muscles if needful. The ligature should be applied as far within the notch as possible, almost within the pelvis, as the gluteal divides immediately after its exit.

Old Operation.—The following is the account of Prof. Syme's case. The man had been stabbed in the buttock seven years before. The aneurism measured more than 13 inches in both diameters; this, together with the great thinness and laxity of the coverings being opposed to coagulation, led to the adoption of the old operation.

"The patient having been rendered unconscious and placed on his right side, I thrust a bistoury into the tumour, over the situation of the gluteal artery, and introduced my finger so as to prevent the blood from flowing, except by occasional gushes, which showed what would have been the effect of neglecting this precaution, while I searched for the vessel. Finding it impossible to accomplish the object in this way, I enlarged the wound sufficiently for the introduction of my fingers in succession, until the whole hand was admitted into the cavity, of which the orifice was still so small as to embrace the wrist with a tightness that prevented any continuous hæmorrhage. Being now able

to explore the state of things satisfactorily, I found that there was a large mass of dense fibrinous coagulum firmly impacted into the sciatic notch, and, not without using considerable force, succeeded in disengaging the whole of this obstacle to reaching the artery. . . . The gentleman who assisted me being prepared for the next step of the process, I ran my knife rapidly through the whole extent of the tumour, turned out all that was within it, and had the bleeding orifice instantly under subjection by the pressure of a finger. Nothing then remained but to pass a double thread under the vessel and tie it on both sides of the aperture." The case did perfectly well.* (*Obs. in Clin. Surg.*, p. 169.)

If, in the case of a stab, the hæmorrhage continue after the ligature has been applied with the above precautions, and the gluteal has evidently been punctured within the pelvis, the internal iliac must be tied after the wound in the buttock has been firmly plugged with iodoform gauze wrung out of carbolic acid (1 in 20).

Macewen's Method (p. 541).—A case thus treated successfully in the Edinburgh Infirmary by Mr. Miller is recorded (*Brit. Med. Journ.*, 1893, vol. i. p. 1176).

The patient here was aged seventy-five on June 1, 1891. The surface of the swelling having been well cleansed, six long aseptic steel pins were introduced into the sac in different directions, and made to pass through it until they were felt to impinge against the opposite wall. They were then withdrawn a little so that their points might scratch the inner surface of the cavity. The pulsations of the swelling were sufficiently powerful to move the points of the pins, and to cause them to irritate the internal wall of the aneurism. They were left in about half an hour, and when withdrawn the punctures were covered with collodion. No anæsthetic was given, nor did the patient complain of much pain. On June 12th the above treatment was repeated, only four pins being used now, as two of those used before were found to be too fine on this occasion, as they bent when force was used to make them perforate the now thickened wall of the aneurism. On June 25th no pulsation could be detected in the aneurism, which had shrunk considerably. At this date a pulsating swelling was felt between the xipho-sternum and umbilicus. July 10, the gluteal aneurism was quite firm to the touch. The abdominal swelling increased rapidly. At first it was thought to be another aneurism, but it was later diagnosed as malignant, the pulsation of the aorta being transmitted through it. The patient sank on August 30. At the autopsy a large, soft sarcoma was found infiltrating the upper part of the abdomen. The gluteal aneurism was found to be quite firm and solid. It was mostly filled with firm fibrous clot, a small part in the centre being softer.

LIGATURE OF THE SCIATIC ARTERY.

Indications.—Stab. This operation is so very rarely required that it may be very briefly described here.

Surgical Anatomy.—The sciatic artery emerges, together with the sciatic nerve and the pudic artery, from the lower part of the great sacro-sciatic notch below the pyriformis.

GUIDE AND LINE.—The limb being rotated inwards, a line is drawn from the posterior superior spine to the ischial tuberosity.

* Nowadays, the application of a Lister's tourniquet to the abdominal aorta would facilitate matters. Another successful case is recorded by Mr. J. Bell (*Prin. of Surg.*, vol. i. p. 1801).

The exit of the sciatic and pudic arteries corresponds to the junction of the middle and lower thirds of this line.

Operation (Fig. 147).—The sciatic artery may be found by one of two incisions, (a) by a horizontal one, about 5 inches long, made about $1\frac{1}{2}$ inch below that for the gluteal artery, and, like that, parallel with the fibres of the gluteus maximus. (b) By one made vertically in the above given line. The deeper guides will be the margins of the notches, or the great sciatic nerve.

LIGATURE OF THE ABDOMINAL AORTA.

Indications.—As this most rare operation has been fatal in every one of the cases in which it has been performed (some nine or ten), its justifiability has naturally been called in question, on the one hand, the desperate condition of the patients, the advanced amount of disease probably present in their arteries, hearts, &c., the large and rapid blood-current, the disturbance of very vital parts, and the risk of peritonitis, all combine to render the probability of success extremely small. On the other hand, recent improvements in surgery, the introduction of better ligatures, the fact that in these cases life must speedily end if nothing is done, and, perhaps, the fact that many of the large operations of surgery have been unsuccessful at first, will justify surgeons in again making trial of this forlorn hope, if they feel certain that, otherwise, the case is quite hopeless.

The cases have mostly been those of iliac and inguinal aneurism, in which other arteries have been tied without success. To justify the epithet above given of “desperate,” the first case, the well-known one of Sir A. Cooper (in 1817),* may be alluded to.

Here the patient had long suffered from an aneurism affecting the external and common iliac arteries, leading to sloughing of the skin and hæmorrhage. Sir Astley having failed in an attempt to perform the old operation, owing to the artery lying so deeply, gave the patient “the only hope of safety” which remained, by tying the aorta.

As life was here prolonged for forty hours, and as in Monteiro’s case death did not take place till the tenth day, proof is given of the restoration of the collateral circulation.†

Mr. Mitchell Banks records briefly (*Brit. Med. Journ.*, 1892, vol. ii. p. 1164) the following most interesting case :

* *Prin. and Pract. of Surg.* (edited by Dr. Lee), vol. i. p. 228.

† In comparing instances of the restoration of the circulation, the one by disease and the other after the surgeon’s ligature, the importance of the slow and gradual process in the one case will not be lost sight of. Mr. Barwell (*Intern. Encycl. of Surg.*, vol. iii. p. 481) alludes to the experiments of Pirogoff (Waller and von Gröfe’s *Journ.*, Bd. xxvii. s. 122) and a paper by Kast (*Zeit. f. Chir.*, Bd. xii. s. 405) to show that the collateral circulation is established. Sir A. Cooper (*loc. supra cit.*) used to show in his lectures an injected specimen from a dog which survived the operation. Beyond this fact, however, no comparison can be made between the chance of survival of healthy animals and that of patients reduced to such straits as to call for this operation.

About fifteen years before a patient in a state of exhaustion came under his care with a rapidly increasing aneurismal swelling occupying the left iliac region, and reaching to the middle line in front and to the umbilicus above. "It was impossible to say where it sprang from, but as the man evidently had only a short time to live, it was necessary to act promptly. I opened the abdomen in the middle line, which was thought rather an adventurous proceeding in those days, with the intention of tying the common iliac, or the aorta itself, if I got a chance. But it was found impossible to do anything. The aneurism overlapped the left common iliac and the lower portion of the aorta, so that neither of them could be reached. It was a gigantic thing and had been leaking for some time at the back, tearing up the tissues behind the peritonæum in all directions." The patient sank a few days later. No autopsy is mentioned.

In addition to the above cases, in which the aorta has been tied in cases of aneurism, it has been tied once for hæmorrhage after a gun-shot injury of the upper part of the thigh by Czerny, of Heidelberg. Hæmorrhage continuing, the common femoral was tied, together with the superficial femoral below the profunda. Bleeding taking place again in six days, the common iliac was tied. The hæmorrhage still persisting, it was thought that the external iliac only had been tied, and a ligature was next placed, by mistake, upon the aorta. The patient lived twenty-six hours. The same surgeon during a nephrectomy for a soft malignant growth of the kidney met with such uncontrollable hæmorrhage as to compel him to tie the aorta, the patient dying soon after.

Surgical Anatomy.—The lowest part of the aorta—viz., that between the bifurcation and the origin of the inferior mesenteric—is that which should be chosen.*

The vessel may have in front of it the omentum, duodenum, mesentery, small intestines, and more closely, the aortic plexus of the sympathetic, and a layer of fascia of various strength. To the right side lies the vena cava, and behind it are the left lumbar veins. The bifurcation is usually situated a little to the left side of the umbilicus and about $\frac{3}{4}$ inch below it.

Operation.—This may be performed (A) through, or (B) behind, the peritonæum. The intra-peritonæal method is especially indicated when the height at which the ligature must be applied, or any evidence of matting of the structures of the abdominal wall (dating to any inflammation about the aneurism, or to the use of pressure), would probably interfere with stripping up the peritonæum.

A. Through the Peritonæum.—The bowels having been emptied as much as possible, the skin cleansed, the shoulders raised, and the knees slightly flexed, the surgeon makes an incision at least four inches long, in the middle line, with its centre opposite to the umbilicus, but curving a little to the left here, so as to avoid the round ligament of the liver and the urachus. The linea alba being found and divided, the fascia transversalis slit up, all hæmorrhage must be arrested before opening the peritonæum.† When this structure has been opened to the whole extent of the wound

* This interval varies in length from $\frac{1}{2}$ inch to 2 inches.

† In Mr. James's case (*Med. Chir. Trans.*, vol. xvi. p. 10) a large quantity of blood was found post-mortem in the abdominal cavity. This had come either from a vessel in the parietes, or from one wounded in the mesentery.

retractors are inserted, and the small intestine and mesentery drawn partly upwards and partly to the sides, carbolised sponges, attached to silk, being packed around, if needful, to keep the above structures out of the way. The pulsation of the vessel is now felt for and the deeper layer of peritonæum carefully scratched through. Care should be taken to disturb as little as possible the aortic plexus* during this step and in passing the needle, which should be carried from right to left.

The ligature used should be one of the flat tape-like ones, of kangaroo tendon or sufficiently stout silk (p. 521). The passage of the needle may be attended with much difficulty,† not only from the depth of the vessel, and from the presence of intestines if distended and allowed to protrude into the wound, but also from the denseness of the cellular tissue surrounding the artery.

B. *Behind the Peritonæum* (Fig. 146).—This method should be tried in any case where the surgeon is unable to take those precautions for which intra-peritonæal surgery calls. The chief objection is the great depth at which the artery is reached, but it is well worthy of notice that in Monteiro's case, which survived ten days, this method was made use of.

The operation is performed on much the same lines as that already given for ligature of the common iliac (p. 607). The incision should be as free as possible, from the top of the tenth rib, curving somewhat forwards to the anterior superior spine.‡ The muscles and transversalis fascia being cut through, the peritonæum is stripped up and turned inwards, several large retractors placed in the wound, and the ribs dragged up and outwards. The common iliac being found this vessel is traced up into the aorta (Fig. 146).

Treatment by Acupuncture.—This method has been fully alluded to at p. 541, and a brilliantly successful case of abdominal aneurism treated by Prof. Macewen with needles, and the formation of white thrombi will be found at p. 542.

Treatment by the Introduction of Wire.—This method has been described at p. 540. Prof. Loreta of Bologna has applied it to one case of abdominal aneurism which attracted much attention at the time, but proved, as is so common in these cases, only temporarily successful. An account will be found (*Brit. Med.*

* Sir A. Cooper (*loc. supra cit.*) believed that his experiments on dogs proved that inclusion of this plexus, and not the interruption of the circulation, was the cause of the paralysis which followed the experiment. In Mr. James's case, when the ligature was tightened, the patient complained of "deadness in the lower extremities." This was soon followed by agonising pain in the same parts, only relieved by death about three hours after the operation.

† Thus, in Mr. James's case the aneurism-needle broke at its handle, the surgeon having "little anticipated occasion for so much force." In one case the sac gave way during the operation.

‡ If necessary, a horizontal one might be added, at right angles to the first, but the rectus and the deep epigastric should on no account be interfered with.

Journ, vol. i. 1885, pp. 745, 955), taken from the original paper (*Mem. Roy. Acad. Scien. Institute of Bologna*, Feb. 8. 1885).

The patient was a sailor, aged thirty, who had always had good health, save for syphilis five years before. Nearly two years before his admission he had felt something give way in the belly while making violent efforts. A large aneurism occupied the epigastric and left hypochondriac regions. An incision having been made from the ensiform cartilage to the umbilicus, numerous superficial adhesions were found, and carefully separated, but it was found impossible thus to deal with deeper ones uniting the sac to the stomach, spleen, and diaphragm. Hence it was impossible to trace the aneurism to its mouth, nor could it be compressed and emptied. It remained uncertain therefore, at the time, whether the aorta or one of its branches was the vessel involved. The vessel, which was now fully exposed on its right side, was punctured with a fine trocar, and silvered copper wire passed in from above downwards and to the left. As soon as the wire met resistance the cannula was removed, the end of the wire pushed in, and the puncture brushed over with pure carbolic acid. A little over two yards had been introduced. The after-course was one of rapid and progressive recovery. The man was allowed to get up at the end of six weeks, the swelling having consolidated, the bruit having disappeared, the pulsation being only communicated, and the femoral pulse, which had been almost suppressed, having reappeared. The patient died suddenly ninety-two days after the operation from rupture of the aorta immediately below the sac at the angle of juncture between this and the aorta. The sac, filled with organising fibrine had shrunk to the size of a walnut. The wire was found unaltered and rolled up in a globular mass. Prof. Loreta suggested that the compression produced by the coagula in the sac might have caused an interference with the blood-supply to the arterial wall just below the swelling and so induced rupture of an artery no doubt already diseased

CHAPTER II.

OPERATIONS ON HERNIA.*—OPERATIONS FOR STRANGULATED HERNIA.—RADICAL CURE OF HERNIA.

OPERATIONS FOR STRANGULATED HERNIA.

Chief Indications for Operation and Points to bear in Mind.—While this is not the place for going into the above fully, a few practical remarks on those indications usually given may be helpful to some of my readers.

i. A lump in one of the openings more or less hard, tense and tender, partly or completely irreducible, and with impulse doubtful or absent.

a. The swelling may be small and deep-seated, as in a bubonocoele near the internal ring, or a femoral hernia in a fat patient.

b. Two herniæ may be present, both irreducible. The surgeon should operate on the one which is the more tense and has the least impulse, and the one which has most recently descended. If this fail to give relief, either the opposite swelling must be explored or abdominal section performed in the middle line. This step will probably allow of the opposite hernia being reduced from within, and also of any other possible seats of strangulation being explored—viz., the inner aspects of the deeper rings.

c. As to the impulse, it is worth while to observe carefully the point where this ceases. This, probably, is over the site of stricture, and should be about the centre of the incision.

On this most important point of impulse Mr. W. H. Bennett (*Lancet*, vol. ii. p. 1378), speaks as follows:—In a case of strangulated omental inguinal hernia with commencing gangrene of the omentum, there yet was no interference with the action of the bowels, constipation and vomiting were alike entirely absent, but the symptom which conclusively called for operation was the entire absence of real hernial impulse. The following remarks on the detection of impulse are worthy of the most careful attention:—"The impulse in ordinary non-strangulated hernia, whether the

* The different forms of hernia, those which present on the thigh as well as the inguinal and umbilical varieties, will be considered here for the sake of convenience, and because they are all abdominal in origin.

contents of the sac be omentum or bowel, is *expansile* in character, that is to say, the tumour when the patient coughs or strains, not only rises under the hand, but expands in size. In hernial tumours containing bowel this sudden increase in the bulk is principally due to the additional quantity of gas, &c., which is suddenly driven into the herniated portion of gut by the act of coughing or straining. In omental herniæ the expansion is partly due to the sudden turgescence in the omental vessels, and partly to the increase of tension in the sac due to the cough. Naturally, therefore, the amount of expansion is relatively greater in herniæ containing bowel than in those composed of omentum. . . . In strangulated hernia it is important to understand that absence of impulse does not necessarily mean *immobility* during coughing, for a hernia, even if tightly strangulated, will often move freely under the hand, especially if it be omental. This movement is, however, rather of the nature of a jump or jerk, and is never expansile. There is no question which has a more practical bearing upon the treatment of strangulated hernia than the expansile character of this impulse. It may be safely held as a surgical dictum, that *every case of hernia in which any change has taken place in the condition of the tumour, such as increase of size or tension, whilst expansile impulse is absent, should be regarded as strangulated.*"

d. Sir J. Paget (*Clin. Lect.*, p. 108) thus writes of the hardness of a hernia:—"In large herniæ the hardness may chiefly be felt at and near the neck and mouth of the sac, especially in inguinal herniæ, and you must take care not to be deceived by a sac which is soft and flaccid everywhere except at its mouth, for there may be strangulated intestine in the mouth of the sac though the rest contain only soft omentum or fluid not sufficient to distend it; nay, you must not let even a wholly soft condition of the hernia, or an open external ring, weigh down against the well-marked symptoms of strangulation, for the piece of intestine at the mouth of the sac may be too small to give a sensation of hardness, or the whole hernia may be omental."

ii. Constipation becoming absolute, even as to flatus. It is well known that small scybalous motions may be forced out by the straining of a patient with a strangulated hernia anxious to get his bowels to act. Further, and in intestinal obstruction generally, the bubbling away of an enema may simulate the passage of flatus. In those rare cases where, other evidence of strangulation being present, the bowels continue to act at intervals, it is probable that the constriction of the bowel is not complete, and leaves a channel along the mesenteric border. If such cases have been left long, owing to the absence of constipation and, perhaps, the slightness of the vomiting, the surgeon must examine the bowel very carefully before he return it. Constriction, though only partial, may have here caused, from its long duration, thinning or ulceration of the intestine at one spot, and faecal extravasation may take place as soon as the bowel is

returned. If there is any reason for doubt in these cases the stricture should be thoroughly divided and the bowel left *in situ*.

iii. Vomiting.* Especially if (a) this is changing from the early rejection of stomach contents or bile to feculent fluid; (b) even if it is repeated only at long intervals, and all other signs are absent or little marked; (c) it must be remembered that vomiting may be stopped by drugs, strangulation persisting, or the intestines may be empty.

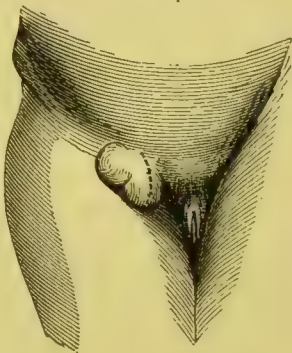
iv. Tympanites and other evidence of peritonitis.

These will not, of course, debar the surgeon from operating, but they will lead him to warn the friends that relief will probably come too late.

STRANGULATED FEMORAL HERNIA (Fig. 148).

Operation.†—The parts being shaved and thoroughly cleansed according to the directions fully given in the footnote to page 657, a little iodoform rubbed in around the genitals, the limbs being kept warm with blankets and a hot bottle or two, if the patient's vitality is low, and the knee flexed slightly over a pillow, an incision $1\frac{1}{2}$ to 2 inches long is made vertically on the inner side of the swelling.‡ Some small branches of the superficial external pudic occasionally require torsion or ligature. The cribriform fascia and the fascia propria (femoral sheath and septum crurale) are next divided in the same vertical line with or

FIG. 148.



* Sir J. Paget (*loc. supra cit.*, p. 112) says: "If I were asked which of the signs of strangulation I would most rely on as commanding the operation, I should certainly say the vomiting." Later on (p. 114) he urges that the practitioner should not wait for any characteristic mode of vomiting, nor be misled by the absence of any particular fluid, nor even by the absence of all vomiting, nor under-estimating the importance of occasional vomiting as a signal for operation.

† While general anæsthesia will be preferred in most cases from the more certain loss of sensibility and the relaxation of the parts, a case related by Dr. Mason (*Brit. Med. Journ.*, vol. i. p. 834) shows how valuable cocaine may be as a local anæsthetic. A woman who had suffered from heart disease for many years required operation for a strangulated femoral hernia. Three four-minim injections of a 4 per cent. solution of cocaine were given, the first under the skin over the centre of the tumour, the second above and the third below the tumour, as deeply towards the femoral ring as was thought safe. It was only during actual division of the sac and the insertion of the sutures that any pain was complained of. The wound healed by first intention.

‡ This incision is usually made in the ordinary way. A somewhat quicker method is by incising or transfixing a fold pinched up at a right angle to the long axis of the swelling, and held by the fingers of the surgeon and an assistant. Before beginning the operation, the surgeon should always examine into the

without a director,* according to their thickness and the experience of the operator, all the incisions made going quite up to and above the top of the swelling, so as to lie over the seat of strangulation, usually Gimbernat's ligament.

In the operation without opening the sac,† the site of stricture must next be found. The varieties here are best given in Sir James Paget's words (*loc. supra cit.*, p. 132): "In some instances, as you trace up the neck of the sac, you find it tightly banded across by a layer of fibrous tissue called Hey's ligament—a layer traceable as a falciform edge of the fascia lata, where that fascia, bounding the upper part of the saphenous opening, is connected with the crural arch, and is thence continued to Gimbernat's ligament. Sometimes a fair division of this layer of fibres up to the edge of the crural arch is sufficient to render the hernia reducible. . . . But in more cases this is not sufficient, and you may feel the stricture formed by bands of fibres which encircle the neck of the sac, and which must be divided, band by band and layer by layer, till none can be felt. These fibres are part of the deep crural arch. Very rarely, however, even the division of these is not sufficient, for the stricture is formed by thickening of the mouth of the sac itself. This condition, which is a common cause of stricture in inguinal hernia, is very rare in femoral; but it certainly does occur, and in any case well suited for the operation, without opening the sac, you may try to thin the mouth of the sac without opening it, and thus to make it extensible enough for the return of its contents. You may try this, but the chances of success are small. You are much more likely to cut into the sac at some thin place, and when you have done this you had better enlarge the opening and divide the stricture from within."‡

Operation by Opening the Sac.—In this and in the former case much difficulty is occasionally met with in deciding as to whether the sac is reached or no. The causes of difficulty here are mainly—(1) An altered condition of the soft parts from the

probable amount of fat, and thickness or thinness of the hernial coverings. In the case of a large hernia turning outwards and upwards, it may be well, at a later stage of the operation, if any additional exploration is required of doubtful contents, to convert the first incision into a —.

* The operator can also manage very well with scissors, keen-edged, but blunt-pointed, first nicking each layer and then separating it from the next with the closed points.

† Cases best suited for this plan are those where the strangulation has been short; its symptoms not very severe—*e.g.*, the vomiting only bilious; where the hernia is small in size and without mixed contents; where the patient is in good condition, and any previous taxis has been gentle and brief.

‡ In trying to divide points of stricture outside the sac, attention should be paid to the following:—(1) First reaching the sac itself, if possible, by a careful division of all the overlying structures in the vertical incision carried well upwards; (2) Carefully drawing down the sac, so as to expose any fibres constricting its neck; (3) Gently insinuating the point of the director under any bands met with.

pressure of a truss, or from long strangulation; (2) from meeting with fluid outside the sac; (3) from the extreme thinness of the patient, which leads to the sac being reached unexpectedly; (4) from the opposite condition, much fat being met with in several of the deeper layers, making it uncertain which is the extra-peritonæal layer, the fat in these cases being often soft, and readily breaking down under examination; (5) an apparently puzzling number of layers—this condition is usually due to “hair-splitting” over-carefulness on the part of the operator, at other times it is brought about by a much thickened fascia propria* separated into imperfect layers by its softened condition or inflammatory matting; (6) by the absence of a sac.†

Aids in Recognising the Sac in Cases of Difficulty.—Several of those ordinarily given (Erichsen, *loc. supra cit.*)—e.g., “its rounded and tense appearance, its filamentous character, and the arborescent appearance of vessels on its surface”—are, I think, quite fallacious. So, too, with regard to the escape of fluid from the sac, for this is often dry in femoral herniæ, and occasionally fluid is met with before the sac is reached. A smooth lining characteristic of its inner surface is more reliable, but the inner surface of the fascia propria is sometimes remarkably smooth. Two points remain which will help to solve the doubt—(a) To draw gently down the doubtful structure, whether sac or bowel, and to examine whether it is continuous above and below with the structures of the abdomen and thigh, like the other coverings of the hernia, or whether it has a distinct neck to be traced into the abdominal cavity; (b) To see if the point of a Key’s director can be insinuated along this last doubtful layer into, and moved within, the peritonæal cavity or no. In a very few cases the surgeon, if still in doubt, incises carefully the suspected layer, and tries if he can pass in a probe and move it from side to side; if this can be done, he is still outside the bowel, not between the peritonæal and muscular coats of intestine.

The sac being carefully nicked with the scalpel-blade held horizontally at a spot where it can best be pinched up with dissecting-forceps, a matter of much difficulty at times owing to its tenseness.

* The fascia propria, though sometimes of wafer thinness, may be much thickened and difficult of recognition. In Sir J. E. Erichsen’s words (*Surgery*, vol. ii. p. 821), “It not unfrequently happens that, after the superficial fascia has been divided, an oval, smooth, and firm body is exposed, which at first looks like the hernial sac or a lump of omentum. This is in reality the fascia propria, thickened by the long-continued pressure of the truss, and congested perhaps by the attempts at reduction; and in the midst of it the sac will at length be found, after the dissection has been carried through several layers of this tissue.”

† A sac is said to be absent in some cases of hernia of the cæcum, and where the patient has been operated on before. This, however, was not the case in three herniæ containing the cæcum, and in two which had been operated on before which have come under my care.

is slit up on a director, and its contents examined. If omentum first present itself, this is drawn to one side and unravelled, and intestine sought for. This usually takes the form of a small, very tense knuckle, of varying colour and condition. If it will facilitate the manipulations needful for reduction, the omentum may be first dealt with. (1) If this be voluminous and altered in structure, it should be tied,* bit by bit, with reliable chromic gut, and then cut away, the scissors being applied so close to the ligatures as to leave holding-room, but no excess to mortify or slough. After the return of the intestine, the omentum is also replaced within the abdomen. (2) If the omentum is small in amount and recently descended, it may be merely returned. (3) In a few rare cases when the omentum is intimately adherent to the sac, and the patient's condition does not admit of delay, the omentum may be left *in situ*. As, however, this course very much interferes with the satisfactory wearing of a truss, and as it is likely to lead to a fresh descent of bowel, it should never, if possible, be followed.†

Reduction of the Intestine.—As soon as this is exposed, the surgeon examines with the little finger-nail, or a Key's director, the tightness of Gimbernat's ligament. In a few cases reduction may be at once effected by gentle pressure backwards on the bowel with the tip of the little finger. But in the large majority the above site of structure will need division, a point requiring much carefulness for fear of injuring the intestine or important surrounding structures. If the degree of tightness of the parts admit of it, there is no director equally safe and satisfactory as the index or little finger of the left hand passed up to the stricture, and the nail-tip insinuated beneath this, the hernia-knife being introduced along the pulp of the finger (Fig, 149). But there is rarely room for this, and a Key's director‡ must usually take the place of the finger. The tip of this instrument being insinuated into the peritonæal cavity just under Gimbernat's liga-

* For security's sake the ligatures should be made to interlock. If hæmorrhage occur from the omentum after it has been replaced, the surgeon must remember that returned omentum generally escapes far from the wound. It will thus be usually needful to extend the wound upwards along the linea semilunaris.

† The cause of the symptoms of strangulation which undoubtedly arise in herniæ containing omentum only, has been much discussed. Mr. Rushton Parker thinks that the symptoms are due either to the displaced omentum dragging on the colon, or to peritonitis: thus an inflamed omental hernia will throw out much serum and simulate strangulation. Mr. Holmes, who shows (*Lancet*, May 4, 1883) that the above explanations will not meet all cases, suggests that in some of the cases the function of the intestine is suspended by some reflex act arising in the nerves of the strangulated omentum.

‡ This director is broad, so as to prevent any intestine curling over and reaching the knife; blunt-pointed, so as not to damage the contents of the peritonæal cavity; finally, its groove does not run quite up to the end, so that the knife-point shall be stopped before it comes in contact with the important parts.

ment, the hernia-knife * is introduced obliquely or flat-wise upon it, its end slipped under and beyond the ligament, its edge turned towards the constricting fibres, and a few of these gently cut through in an upward and inward direction. In doing this it is

FIG. 149.†



(Fergusson.)

well for the surgeon to draw down the edges of the cut sac close to its neck, and to ask an assistant to hold these, thus facilitating the passage of the director and the knife by preventing the sac falling into folds before them. Occasionally also a knuckle of intestine persistently coils over the

edge of the director. This is best met by patience, by drawing it out of the way by the carbolized finger-tip of an assistant, or by pressing it down with the handle of a pair of dissecting-forceps.

The direction and the extent to which the stricture must be cut are matters of much importance. The upward and inward line is the only path of safety. Directly outwards lies the femoral vein; by cutting upwards, the spermatic cord, and, if upwards and outwards, the epigastric artery, would be endangered; behind are the peritonæum and pubes. The incision upwards and inwards must be of the nature of a nick; otherwise, owing to the imperfect healing of the fibrous structure, the ring will be left large and gaping, thus facilitating the re-descent of the hernia, and producing much difficulty in fitting on trusses, and causing certain discomfort and probable peril to the patient, especially if she belong to the poorer, hospital class.

Gimbernat's ligament having been carefully and sufficiently nicked, the bowel is replaced either by gentle squeezing between the finger and thumb, so as to empty it of its contents, or with the pressure of the little finger; the sac should now be kept stretched with forceps so that no folds interfere with the return of the bowel. If pressure on one part of the intestine fail, it must be tried at another point. After the reduction of the intestine the tip of the little finger should be introduced through the crural canal into the peritonæal cavity to see that the gut is absolutely safe; a little iodoform is then dusted on to the stumps of omentum, and these too returned, if this has not been done.

If the patient's condition and age admit of it, and if the

* A curved one will be found most useful. The cutting-blade is usually too broad, and the tip too massive. On the other hand, a worn-down blade has been known to break while dividing a tense Gimbernat's ligament. The intestine may thus be wounded, or the fragment of the knife escape into the peritonæal cavity.

† The cutting-blade of the knife shown here is needlessly long and unguarded.

adhesions are not too firm, the sac should next be taken away by carefully separating it with the finger or a director from its attachments. It should then be pulled well forwards, an aseptic finger introduced up to its neck, this part next ligatured with stout chromic gut as high up as possible, the finger then withdrawn, and the sac cut away $\frac{1}{2}$ inch below the ligature. If the surgeon is at all doubtful about the safe ligature of any stump of omentum, he should keep this down and transfix it and the neck of the sac with a double chromic-gut ligature, the ends of which are afterwards cut short. Sufficient drainage is now provided by a small tube or a bundle of horsehair, and the superficial wound closed. The dressings must be applied with sufficient care to keep the wound secured from obviously close sources of contamination. It is well to place a separate pad of carbolized tow or salicylic wool over the anus and genitals, and to draw the water off before the patient leaves the table. The thigh should not be kept too much flexed, otherwise the escape of discharge from the drainage-tube will be interfered with.

The account of an ordinary operation having been given, it remains to consider certain **complications**. These are chiefly :

1. Adhesions of Bowel to the Sac or Omentum.—The treatment of this uncommon complication must vary with (*a*) the character and position of the adhesions, (*β*) the condition of the intestine, and (*γ*) the state of the patient. Owing to the difficulty of fitting on a truss if any of the hernia is left unreduced, every attempt should be made to free the contents by separating the adhesions with the point of a steel director, the finger-nail, or a blunt-pointed bistoury. When near the neck they must always be divided, sufficiently nicked, or stretched. No intestine and omentum if still adherent to each other should ever be returned. A few cases remain in which adhesions should be left alone. When gangrene is threatening (p. 633), but the operator is too short-handed to face resection of the affected intestine, the presence of adhesions, especially about the neck of the sac, is the chief safeguard against extravasation into the peritonæal cavity. In some cases of large hernia, if the patient is much collapsed, so long as any recently descended loop is returned any long-adherent intestine may be left. And in other cases of collapse from delay of the operation, where there is much difficulty in returning a loop of intestine, especially if this is not in good condition, it may be left, after the stricture has been sufficiently divided.

It occasionally happens in these cases of deeply congested bowels, especially in inguinal hernia, that after an otherwise successful herniotomy the patient passes profuse and bloody stools. This condition may prove fatal. In one or two cases of this kind which have come under my notice the operator was, most unfairly, blamed for having incised the bowel.

Mr. Kough (*Lancet*, Oct. 11, 1884) records a case in which a patient died in collapse two hours after the reduction of a very large scrotal hernia. The pelvic

cavity was full of blood-stained serum ; ten feet of intestine were found dark purple in colour, but uninjured. On laying the gut open about $1\frac{1}{2}$ pints of blood escaped.

2. Tightly Constricted or Gangrenous Intestine.—In spite of all that has been taught about the importance of early operations, cases do still occur in which returning the bowel is doubtful or out of the question. In most cases of doubt, as long as the stricture is sufficiently divided and the intestine placed only just within the crural ring (the wound being left open and the sac not ligatured in these cases), the interior of the abdomen is the best place for the intestine. And this is true of congested intestine, however deeply loaded with blood only, as long as there is some shade of red present. But on these points nothing will surpass the advice of Sir J. Paget (*loc. supra cit.*, p. 138): “You are to judge chiefly from the colour and the tenacity. Use your eyes and your fingers ; sometimes your nose ; very seldom your ears, for what you may be told about time of strangulation, sensations, and the rest is as likely to mislead you as to guide aright. As to colour I am disposed to say that you may return intestine of any colour short of black, if its texture be good ; if it feels tense, elastic, well filled out, and resilient, not collapsed or sticky ; and the more the surface of the intestine shines and glistens, the more sure you may be of this rule. When a piece of intestine is thoroughly black, I believe you had better not return it, unless you can be sure that the blackness is wholly from extravasated blood. It may not yet be dead, but it is not likely to recover ; and, even if it should not die after being returned, there will be the great risk of its remaining unfit to propel its contents, and helping to bring on death by what appears very frequent—distension and paralysis of the canal above it. But, indeed, utter blackness of strangulated intestine commonly tells of gangrene already ; and of this you may be sure if the black textures are lustreless, soft, flaccid or viscid, sticking to the fingers, or looking villous. Intestine in this state should never be returned. Colours about which there can be as little doubt, for signs of gangrene, are white, grey, and green, all dull, lustreless, in blotches or complete over the whole protruded intestine. Then as to the texture of the intestine : It should be, for safety of return, thin-walled, firm, tense, and elastic, preserving its cylindrical form, smooth, slippery, and glossy. The further the intestine deviates from these characters, the more it loses its gloss and looks villous, the more it feels sticky and is collapsed and out of the cylinder form, the softer and more yielding, the more pulpy, or like wet leather or soaked paper, the less it is fit for return. And when these characters are combined with such bad colours as I have described, the intestine had better be laid open, that its contents may escape externally and do no harm.”

In other long-standing cases of femoral hernia the chief stress of the constriction is shown, not on a dying loop of intestine, but

in ulceration, partial or nearly ring-like, at the neck of the sac, under the sharp edge of Gimbernat's ligament. Where this condition, owing to the duration of the case, is suspected, the intestine should be very gently drawn down, and, if ulceration is found, laid open. If the mischief is localized and the adjacent intestine fairly healthy and not fixed, it will be well to stitch it to adjacent parts to prevent it slipping up into the peritonæal cavity.

The treatment of gangrenous intestine in a hernia is fully dealt with, later on, under the heading of Resection of the Intestine. I will only say here, that wherever possible, *i.e.*, in cases where the condition of the patient, and the experience, and help ready to the surgeon's hand, admit of his taking this step, the gangrenous intestine should always be resected. In a few cases where the above conditions are absent, the surgeon must rest content with opening the intestine and leaving it *in situ*. The quickest way will be to draw the whole loop that is damaged outside the peritonæal cavity, and keep it placed by a sterilized bougie or glass rod of appropriate size, as in inguinal colotomy (q.v.).

It has been much disputed whether, in these cases, when the intestine is unfit to be returned, it is safe or needful to divide the stricture in addition to laying open the intestine. On the one hand, M. Dupuytren, Sir A. Cooper, Mr. Key, and Sir J. E. Erichsen have advocated this step being taken; on the other, Mr. Travers and Sir W. Lawrence were against it. The following words of a very brilliant writer* will probably convince most that this step is not only injurious, but unneeded:—"The only result of this is that the protecting barrier which divides the still aseptic peritonæal cavity from the putrid sac, is broken down, and putridity spreads upwards into the abdomen and kills the patient by rapid septicæmic poisoning. Why break down this valuable wall? If it is argued that, unless the stricture is divided, the contents of the bowel cannot escape, then the reply is that experience proves this to be utterly untrue. In a very short time both flatus and fæces find their way out. As every one knows, the nipping of the gut is not produced by a sudden narrowing of the hernial aperture, but by a swelling of the loop of gut. . . . When the gut is slit up, its contents are set free, and its inflammatory juices escape, with the result that its swelling goes down and room enough is soon permitted for wind and fæces to pass, more particularly as the fæces are invariably quite liquid."

4. Wound of Intestine.—This may be due to (a) carelessly incising thin, soft parts; (b) great difficulty in making out the sac and the intestine in a fat patient, with the parts matted, especially if the light is bad; (c) to the intestine being allowed to curl over the edge of the director while the stricture is being divided, or to

* Mr. M. Banks, *Clinical Notes on Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 96.

this being cut with careless freedom, or, lastly, to a loop lying out of sight just above the constriction, and to the hernia-knife coming in contact with this. Any bubbling of flatus or escape of fæces from the wound must lead to a careful search for the wound. The operation wound being freely enlarged, the wound in the intestine found, temporarily closed with a Spencer Wells' forceps, and drawn quite out of the abdomen, the intestines around are carefully cleansed and packed out of the way and protected with tampons of iodoform gauze or flat sponges. When the wound in the intestine is found, it may usually be tied up around a pair of dissecting-forceps with carbolized silk, the ligature not being tied too tightly, and the ends cut short. If the opening be larger, it should be closed by Lembert's suture (see Suture of the Intestine). Whichever method is used, the injured part should be replaced just within the peritonæal cavity, and in a severe case the sac should not be taken away nor the wound closed. The patient should be kept under the influence of opium, and liquids restricted.

5. Wound of Obturator Artery.—The position of this vessel when it rises by a common trunk with the deep epigastric instead of from the internal iliac, which occurs in every $3\frac{1}{2}$ subjects (Gray), may bear a very important relation to the crural ring. In most cases when thus arising abnormally, the artery descends to the obturator foramen close to the external iliac vein, and therefore on the outer side of the crural ring and out of harm's way. In a small minority of cases,* the artery in its passage downwards curves along the margin of Gimbernât's ligament, and may now be easily wounded.

The treatment is mainly preventive—*i.e.*, by making the smallest nick possible that will be sufficient into any point of stricture, such as Gimbernât's ligament, a point the importance of which has already been alluded to (p. 631), and using a hernia-knife that is not over-sharp. If the artery has probably been wounded, the following points are of interest:—(1) The hæmorrhage may not at once follow the wound. It may not make its appearance till the bowel is all reduced, or even until a quarter of an hour after the wound has been stitched up. In one case, that of Dupuytren, no hæmorrhage occurred, and the division of the artery was discovered for the first time at the autopsy three weeks after the operation. (2) It may occur when the sac has not been opened. (3) As is shown by Dupuytren's case, it is not necessarily a fatal accident. (4) Very various means have served to arrest the hæmorrhage. (a) Pressure, as in the cases of Sir W. Lawrence, Mr. Hey, and Mr. Barker.† This means was successful

* Sir W. Lawrence considered this risk to occur about once in a hundred times, estimating the origin of the obturator with the epigastric to occur once in five, and the descent of the artery on the inner side to take place once in twenty times.

† *Clin. Soc. Trans.*, vol. xi. p. 180. This paper will well repay perusal. Most of the above information is taken from it.

in two out of the three cases in which it has been employed. It should only be resorted to when the patient's condition does not admit of the wound being enlarged, the bleeding points found, and dealt with by ligature or forci-pressure. When pressure has to be trusted to, it should be efficiently employed by means of tampons of iodoform gauze wrung out of carbolic acid lotion (1 in 20) and secured on silk. (β) Ligature of the vessel, usually the proximal end. In five cases given by Mr. Barker, this was successful in four; it is only stated in one that the distal end was also secured. The ligature had been applied in some cases by continuing the wound upwards; in others by making an incision parallel with Poupart's ligament, as if for tying the external iliac. This step should always be taken when the patient's condition is satisfactory.* In two of Sir W. Lawrence's cases the fainting of the patient appears to have decided the cessation of hæmorrhage. Both of these recovered. (γ) In the event of ligature being really impossible, it might be worth while, before taking other steps, to try the application of a pair of Spencer Wells' forceps. These should be left *in situ* for three or four days, and would favour drainage.

(6) Herniæ with Unusual Contents.—These may be (a) Fat herniæ. Both in the inguinal and femoral regions, but especially in the latter, the extra-peritonæal tissue near the rings may become increasingly fatty. Gradually projecting towards the surface it drags down the peritonæum to which it is loosely connected. I have operated on one such case in a girl at nineteen, in whom the fitting of a truss was unsatisfactory. Here I expected to find an omental hernia, Into the pouch so formed intestine or omentum may present. In other cases if the extra-peritonæal fat thus protruded become absorbed, the hollow thus left may produce a space for the peritonæum to project into. (β) Hernia of the ovary. This is much more commonly met with in inguinal herniæ. The chief points in the diagnosis of these difficult cases are the characteristic oval shape and size of the swelling, the peculiar sickening pain when the swelling is pressed upon; the swelling is larger, and the tenderness greater during menstruation, the swelling may sometimes be made to move when the uterus is displaced laterally with a vulsellum, and the ovary of that side is not to be made out per vaginam. Where other treatment has failed, where the swelling is irreducible and prevents the fitting of a truss, where the symptoms are sufficiently urgent to cripple a young life, the displaced ovary should be removed. The operation should be rigidly aseptic. Adhesions are not uncommon. (γ) Hernia of vermiform appendix.

* Mr. Hulke (*Lancet*, 1885, vol. i. p. 746) by freely opening up the wound and using large retractors found a comparatively large atheromatous artery spouting freely. From its position this was a large communicating artery between the deep epigastric and obturator, lying just behind Gimbernat's ligament. Both ends were secured with very great difficulty. The patient did well.

I met with a case of this early in 1890, in a lady, aged forty-three, a patient of Dr. Fraser's of Romford. The femoral hernia was here irreducible, dull, gave a feel of omentum, and curved upwards and outwards in the usual way. As no truss was satisfactory, and as the patient, the wife of a missionary, was to be much abroad, a radical cure was advised. The sac contained much fluid, but no omentum. In the outer part of the hernia lay a thick fleshy body, tubular and expanded at its end. Near Gimbernat's ligament it was constricted and distinctly abraded. After notching the above ligament this body, which proved to be the appendix, was easily returned. The sac was removed. The case did excellently.

In another case I should remove the appendix if there were time for making the necessary suturing secure. (8) Hernia with more than one sac. This may be due to the presence of membrane, inflammatory in origin, which has divided the original sac.

Causes of Herniæ not doing well after the Operation.—

(1) Peritonitis, usually from the operation being performed too late. (2) Enteritis. This may be told by the tympanites, tenderness and vomiting being much less marked, and often, the presence of diarrhoea. (3) Septic trouble, erysipelas. The six following are the causes of intestinal obstruction after operations for hernia. (4) The descent and re-strangulation of the bowel. (5) So much damage to the intestine that it lies paralysed in the peritonæal cavity.* (6) Cicatricial stricture of the intestine. (7) Fixing of the bowel after its reduction by adhesions to the abdominal wall.† (8) Formation of a band out of the above adhesions. (9) Fixing of the two ends of a loop of intestine by adhesions. (10) Formation of an omental band in the neighbourhood of one of the hernial orifices, a band so formed causing obstruction later (*Brit. Med. Journ.*, 1879, vol. ii. p. 491). (11) A very rare condition. The sac may be multilocular; when the intestine is reduced it may be returned into one of these cavities instead of within the abdomen. Mr. Bellamy has published such a case (*Lancet*, 1886, vol. ii. p. 433). A good illustration of this is given by Mr. Holmes's *Surgery*, p. 698, fig. 322; the patient here died eight days after an operation for strangulated hernia.

STRANGULATED INGUINAL HERNIA (Figs. 150, 151).

Operation.—In considering this it will not be needful to go again into detail, as in the case of Strangulated Femoral Hernia; the chief points of difference and those of importance will be considered carefully.

The parts being shaved and cleansed (p. 657), and the thigh a little flexed, an incision $2\frac{1}{2}$ inches long at first is made in the long

* I have recorded (*Brit. Med. Journ.*, 1879, vol. ii. p. 491) an instance of this in which ten days after an operation for intestinal obstruction by bands, death took place from the intestine never having recovered itself.

† This and the next three are given by Mr. Treves, *Lancet*, 1884, vol. i. p. 1022.

axis of the tumour, with its centre (in an ordinary scrotal case* over the external abdominal ring. This incision may be made either by pinching up a fold and cutting from within outwards or by cutting, in the usual way, from without inwards. The pressure-forceps may be left on the external pudics (both superior and inferior), these vessels being finally closed by the sutures which unite the wound. As the layers are divided, the knife being kept strictly in the same line throughout, some arching fibres of the inter-columnar fascia may be seen above, but the first layer usually recognised is the cremasteric fascia, often much thickened. After this the transversalis fascia, often much thickened and vascular-looking, is slit up, and any extra-peritonæal

FIG. 150.



(Fergusson.)

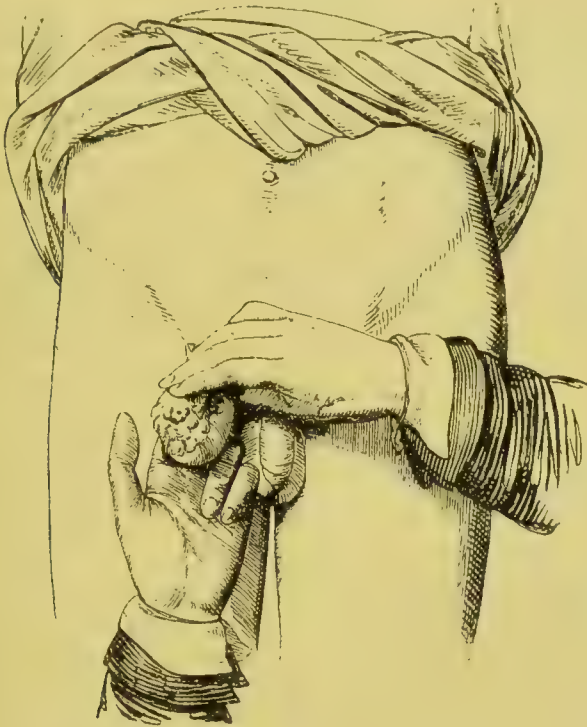
fat overlying the greyish-blue sac looked for. The surgeon now sees if he can find any constricting fibres outside the sac, and slits them up on a director. The more voluminous the hernia the more important it is to avoid exposure and manipulation of its contents by opening the sac.† But in the majority of inguinal herniæ the surgeon must be prepared for opening the sac. As soon as this is

* In a strangulated bubonocoele the centre of the incision should lie over the internal abdominal ring, and, in the deeper part of the incision, the deep epigastric must be felt for and avoided.

† The site of the stricture in inguinal hernia varies. In both varieties, in old cases of long duration, it is usually situated in the neck of the sac itself, owing to contraction and thickening of this and the extra-peritonæal tissue. In other cases of oblique hernia the stricture is found in the infundibuliform fascia at the internal ring, just below the edge of the internal oblique in the canal, or at the external ring. In a direct hernia the constricting point, if not in the sac, is probably caused by the fibres of the conjoint tendon. In many cases the parts are so approximated and altered that in the short time given for an operation it is not so easy to tell exactly in what tissues lie the strangulation, as to relieve it. Finally, in many cases of young subjects and acute strangulation, muscular spasm—*e.g.*, of the internal oblique—must be borne in mind.

done, with the precautions already given (p. 629), the contents are examined, omentum got rid of if this step will give more room, and the site of stricture found with the finger-nail or tip of the director. It is next divided with the hernia-knife manipulated under it in a direction directly upwards, so as to lie parallel with the deep epigastric, whichever side of the hernia this vessel occupies.* During this stage, the steps given at p. 631 must be taken to avoid any injury to the intestine. The constricting point being divided and dilated, the next step is reduction of the

FIG. 151.



(Skey.)

intestine. This, in bulky inguinal herniæ, is often a matter of difficulty and time. The chief causes of difficulty here are— (1) A large amount of intestine, one or two coils of small and some large intestine being not very uncommon. (2) The distension of these with flatus, &c. (3) Insufficient division of the stricture; or there may be a point of stricture higher up than the one divided, and overlooked. (4) During attempts at reduction one bit of intestine may get jammed across the ring instead of slipping up along it, and against this the rest of the contents are

* Of course, if the surgeon is certain that he is dealing with an oblique hernia, he may cut outwards, and, in the case of a direct hernia, inwards, so as to avoid the deep epigastric. In all cases the cut should be of the nature of a nick dividing only those fibres which actually constrict, any additional dilatation being usually now effected by the tip of the director or finger.

fruitlessly pressed. (5) Folds of the sac may in much the same way block the opening.

Aids in Difficult Cases.—First, that part which lies nearest the ring should be taken—*e.g.*, mesentery before intestine. After each part is got up, pressure should be made on it for a few seconds before another is taken in hand. If the surgeon find after a while, that he is making no progress with one end of a coil, he should take in hand the other end, or another coil altogether if more than one is present. Much of the difficulty met with in the reduction of the intestine is due to the surgeon not first unravelling the coil or coils, not duly tracing up the intestine to the ring, so as to make out the relations of the two, and, above all, to his not making up his mind which end of the coil it is exactly which he intends to begin reducing. During the manipulations the thigh should be flexed and rotated a little inwards, and the cut edges of the sac drawn dense with forceps, so as to prevent any folding or pushing up of this before the intestine. If the intestines are much distended, attempts should be made to return some of their contents first into the abdominal cavity. If after by gentle squeezing with the finger and thumb, and careful pressure upwards on each successive bit of intestine, it all appears to be returned, the little finger (aseptic) must be passed into the abdominal cavity to make certain that no knuckle remains in the canal or internal ring.

Another Method.—In the case of large scrotal herniæ, where opening the sac in the ordinary way involves much exposure of peritonæal surfaces, I believe the following to be preferable: A small opening just large enough to admit the left index finger (previously rendered aseptic), is made in the sac just below the seat of constriction. This is then divided on the finger as a director, *from without inwards*. The sac should not be again opened here, but after all the constricting bands have been felt and perhaps heard to give way, the finger easily dilates the communication with the peritonæal cavity and then reduces the contents of the sac. I have used this method twice, and with excellent results. It reduces the necessary disturbance of peritonæal surfaces to a minimum. Where from long strangulation it is advisable to inspect the contents of the sac, or where these are adherent, the sac must be more freely opened.

Cases will occasionally be met with where, owing to the low condition of the patient, the large amount of intestine down, its great distension, its altered condition, still red and only congested, but softened, with the peritonæal coat shaggy rather than lustrous, and tending to tear easily, it is clear that reduction will not be effected by manipulation only. If the distension is due to flatus, punctures may safely be made with a very fine hydrocele trocar. Where fæcal fluid matter is present the above step is dangerous, and a small incision, carefully closed by Lembert's sutures, the inversion being thoroughly carried out, will give the best results. Where the

intestine is much congested and softened, though not yet gangrenous, or where the surgeon has not skilled assistance and all the aids of modern surgery ready to his hand, he had better leave the intestine in the sac after a free division of the stricture.* This method, while under the above conditions, the safer, prevents, of course, any attempt at relieving the patient, at one operation, by a radical cure.

During any prolonged manipulation of the intestines these should be kept covered as much as possible by iodoform gauze wrung out of warm carbolic acid lotion (1 in 20), or lint, the fluffy side being turned away from the bowel. It is wise also that the patient should be well under the anæsthetic now, and breathing quietly. If vomiting occur, the surgeon must wait, keeping up pressure on what he has reduced. When the intestine is all reduced, any ligatured stumps of omentum are returned, and, if the condition of the patient admits of it, the sac is detached, one of the methods of radical cure given p. 659 to 675 made use of, the precautions as to the cord and other points given at p. 657 being carefully followed.

In this, as in other operations, the wound should be carefully sponged with mercury perchloride solution (1 in 4000), and left exposed as little as possible, especially the parts near the opening into the peritonæum.

In providing drainage after an operation on a large inguinal hernia, where the parts have been much handled either before or during the operation, it is well worth while to bring the lower end of a drainage-tube out at the lower part of the scrotum, by means of a counter-puncture there, thus ensuring efficient escape of the discharges, and syringing out of the wound if needful,

After thus considering the chief points in the operation, it remains to draw attention to **some special points connected with inguinal hernia.**

I. *Varieties.*—In addition to the oblique and direct varieties, both of which are acquired, there are some others of much practical importance—*e.g.*, (a) The congenital. The tubular process of peritonæum is open from abdomen to fundus scroti, and the

* This will all gradually and slowly return into the peritonæal cavity. On this point the following case by South (Chelius's *Surgery*, vol. ii. p. 40) is of interest:—"I know by experience that if strangulation be relieved, it is of little consequence how much intestine be down. In reference to this point, I recollect the largest scrotal rupture on which I have operated, and in which, before the division of the stricture, there was at least half a yard of bowel down, filled with air; and, after the stricture had been cut through, at least as much more thrust through, so that I almost despaired of getting any back; yet, after a time, I returned the whole. To my vexation, however, next morning I found that my patient had got out of bed to relieve himself on the chamber-pot, and, as might be expected, the bowel had descended, and in such quantity that the scrotum was at least as big as a quart pot, and the vermicular motion of the intestine was distinctly seen through the stretched skin. Nothing further was done than to keep the tumour raised to the level of the abdominal ring, and by degrees it returned, and the patient never had an untoward symptom."

contents lie in contact with the testis. (*b*) Hernia into the funicular process of peritonæum. Here the tubular process of peritonæum is divided into a shut vaginal sac below and an open funicular process above. Into the latter the contents descend, but are not in absolute contact with the testis. (*c*) Hour-glass contraction of the sac. Here the tubular process is open as in (*a*), but an attempt at closure has brought about a constriction which may be at the external abdominal ring or lower down in the scrotum. If the contents pass through this constriction, and get low enough, they will be in actual contact with the testis. (*d*) Encysted hernia of the tunica vaginalis. Here the funicular process is closed at its upper extremity—*i.e.*, at either ring or in the canal—and open below to the testicle. The hernial protrusion as it comes down either ruptures this septum (when of sudden descent), or gradually inverts it, or comes down behind it. These cases are rare, but may be puzzling when they occur, as the operator has more than one layer of peritonæum to incise before reaching the contents.

That the above varieties have an importance beyond that of anatomical puzzles is shown by the fact that in (*b*), (*c*), and (*d*) strangulation may be very acute and urgent. Again, though the defect is a congenital one, the hernia does not, in many cases, make its appearance till the patient has, in early adult life, been subjected to some sudden strain. Finally, in these cases any prolongation of the taxis will be not only futile, but actually dangerous, owing to the tightness of the strangulation and the facility with which, owing to the delicacy of its adhesions, the sac may be separated or burst.

II. *Reduction en masse, and Allied Conditions.*—These have been chiefly met with in inguinal herniæ owing to the loose connections of the sac and, sometimes, to the force used in attempts at reducing large specimens. Strangulation may persist after (*a*) displacement, or (*b*) rupture of the sac. In the former, the sac, still strangling its contents at its neck, is displaced bodily between the peritonæum, usually, and extra-peritonæal fascia. In the latter, the sac is rent, usually close to its neck and at its posterior aspect, and some of its contents are thrust through into the extra-peritonæal connective tissue. The chief evidence of these accidents is—Though the swelling has disappeared, perhaps completely, this has taken place without the characteristic jerk or gurgle. On close examination, though the bulk of the hernia is gone, some swelling, often tender, is usually to be made out, deep down, in the neighbourhood of the internal ring. Above all, the symptoms persist, perhaps in an intensified form.

The treatment is immediate exploration of the inguinal canal and the internal ring. If the cord is exposed, the whole sac has probably been detached. If any of the sac is left above, a rent in it should be sought for. Supposing the index finger, passed through the internal ring, fail to find any swelling, aided by pressure from above, a vertical incision must be added to the

upper end of the oblique one, and the neighbourhood of the internal ring explored.*

III. *Retained Testis simulating Hernia*.—Such a testis, when inflamed, may closely simulate strangulated hernia. A testis, perhaps, has never descended; a truss has been worn and laid aside. The patient presents himself with a tender swelling in one groin, with indistinct impulse. The abdomen is tense and full, constipation is present, and perhaps vomiting of bilious stuff. Such a swelling should be explored and the testis removed, as it is certain, later on, to cause serious trouble, even if the present urgent symptoms subside with palliative treatment. In other cases a retained testis may draw down an adherent loop of intestine which may become actually strangled.†

STRANGULATED UMBILICAL HERNIA.

Two distinct forms of strangulated hernia will be met with here. One, more rare, is of small size, with a single knuckle of intestine acutely strangled in the navel-cicatrix. The other, the more common, is often huge, its contents mixed, intestine both large and small, and omentum. Such herniæ soon become, in part at least, irreducible; when in this condition, any unwise meal may readily bring about obstruction, a condition requiring much care to tell from strangulation.‡ In other cases a large irreducible hernia may easily become strangulated from the descent of some additional loop of bowel. The adequate fitting of a truss is often a matter of much difficulty here, owing to the large size of the abdomen, the presence of omentum, and, frequently, of an habitual cough.

Practical Points before Operation.—(α) The sac usually communicates directly with the general peritonæal cavity by a large opening. (β) The contents are not only mixed, but of long standing, and often adherent. (γ) The patients are often advanced in life, stout, flabby, and not unfrequently the subjects of chronic

* As this will probably involve abdominal section, the steps given later should be referred to.

† For fuller information on these matters I would refer my readers to *The Diseases of the Male Organs of Generation*, chapter ii. p. 72.

‡ Amongst the most important points will be the vomiting, whether early in onset, constant, and showing signs of becoming feculent, and the constipation, whether absolute, even to the passage of flatus. In doubtful cases the rule should be to operate. "The risk of operating on a hernia which is inflamed and not easily reducible is very small in comparison with the risk of leaving one which is inflamed and strangulated; and even if you can find reasons for waiting it must be with the most constant oversight, for an inflamed and irreducible hernia may at any time become strangulated, and will certainly do so if not relieved by rest and other appropriate treatment" (Sir J. Paget, *loc. supra cit.*, p. 106).

bronchitis. (δ) The coverings are ill-nourished, and slough easily.

Operation.—The parts having been cleansed* by a thorough scrubbing with soap, and soaking with 1 in 1000 solution of mercury perchloride, and an anæsthetic administered, an incision 2 to 3 inches long is made over the lower† part of the swelling in the middle line, the hernia being somewhat pushed upwards to facilitate this.‡ The thinness of the coverings must be remembered. Search should be made for any constricting bands of fibres outside the sac. If it be needful, the sac must be opened, with the knife held horizontally, and slit up, care being taken now and throughout the operation, in cases of large herniæ, that protrusion of intestine be prevented by the means given a little later. The contents having been examined, any intestine is gently displaced upwards, while the surgeon turns the curved surface of a Key's director over the lower edge of the opening, and, guiding the hernia-knife on this, divides the constricting edge downwards. If sufficient space is not given, the downward nick may be repeated, or the director turned against the lateral or upper aspects of the ring, and fibres here also divided.

Adhesions of the contents of the sac are not unfrequently met with. If they are very close and dense, and if the condition of the patient is unsatisfactory, the surgeon should be content with a free division at one or two places of the constricting ring, and with reducing any portion of intestine that has clearly only recently come down, and leave the rest undisturbed.

A complication of large umbilical herniæ is thus well described by Mr. Wood (*loc. supra cit.*, p. 1168):

"In corpulent persons, in whom the operation has been delayed until peritonitis has begun, the operator has frequently to contend with a rush of bowels out of the abdomen. This should be restrained by receiving them in warm towels § wet with carbolic

* This is especially needful here from the numerous wrinkles of the skin, the frequent lack of cleanliness, and, occasionally, a highly septic condition of intertrigo in the folds of fat above the pubes.

† The lower part is here recommended because, in Mr. Wood's words (*Intern. Encycl. of Surg.*, vol. v. p. 1165), "the point of strangulation in an adult umbilical hernia is most frequently at the lower part of the neck of the sac, where the action of gravity, the dragging weight of the contents, and the superincumbent fat, together with the pressure and weight of the dress or an abdominal belt, combine to press downwards upon the sharp edge of the abdominal opening. It is here that adhesions and ulceration of the bowel are most frequently found, and here the surgeon must search for the constriction in cases of strangulation." An incision here also gives better drainage.

‡ If the surgeon intends to attempt a radical cure, and if the skin is diseased, much thickened with old abrasions, he should remove this area by two elliptical incisions.

§ Large squares of iodoform gauze wrung out of carbolic acid (1 in 20) are to be preferred.

lotion, and applying pressure by the hands of assistants. If it can be managed, all the operative proceedings within the sac should be done before such a rush occurs; but if a cough, or vomiting, or anæsthetic difficulty occurs at this juncture, this is sometimes impossible, and the surgeon is compelled to do the best he can. In such cases the operation becomes a formidable one indeed, and is comparable only to laparotomy under conditions of distension of the intestines. The bowels and omentum should always, if possible, be kept in the warm wet towels, and not indiscriminately handled by the assistants, whose arms should be bared and well purified with carbolized lotion. The intestines should always be returned before the omentum, which should, if possible, be spread out* over them before the stitches are applied."

All the intestine and the remains of the omentum, carefully ligatured, being returned if possible, the surgeon now, if the patient's condition admits of it, removes the redundant sac and skin. The opening into the peritonæal cavity being closed with a small aseptic sponge secured to silk, or a flat sponge being inserted, the sac is separated from its connections and cut away close around the ring; any bleeding points can now be arrested by numerous strong sterilized silk or kangaroo-tail sutures passed through the edges of the ring so as to close it save at the lower part, where a small-sized drainage-tube is left with its orifice flush with that into the peritonæal cavity.† Before the sutures are tied, any sponge which has been introduced into the abdomen so as to keep the operation as extra-peritonæal as possible, should be removed. The redundant skin is then cut away and the edges of the wound brought together with stout silk or silver sutures. The drainage-tube may be removed on the fifth or seventh day.

It will be seen from the above account that three methods may be pursued in the reduction of a strangulated umbilical hernia: (1) The division of the stricture outside the sac (p. 628). Where the surgeon is short-handed, this should always be tried, but is rarely successful here. (2) If the sac has to be opened, the opening is made as small as possible, and the ring freely divided at one or two points, but the contents disturbed as little as possible, any recently descended intestine being returned, but thickened omentum, adherent intestine, especially large, being left undis-

* Mr. Wood prefers leaving the edge of the omentum so arranged as to become adherent to the lower margin of the hernial opening, so as to prevent, if possible, any future protrusion, to tying it and cutting it short.

† Mr. Barker (*Brit. Med. Journ.*, 1885, vol. ii. p. 1101) advises the use of a double row of sutures—the first as given above to unite the edges of the ring; the second, to give extra strength to the scar, are passed through the anterior layer of the sheath of the rectus on each side, at about $\frac{1}{3}$ inch from the edge of the ring. On these being brought together, a considerable fold of fibrous tissue is inverted and brought into contact in the middle line, over the first row which closed the ring.

turbed. (3) Free opening of the sac, examination and separation of its contents, return of all intestine and of omentum after ligation and resection.

While the third of these courses has the great advantage of leaving the patient permanently in a more satisfactory condition, as it admits of something like a radical cure,* the surgeon can only rightly decide between this and the second course by a careful consideration of each case. The following points may aid in judiciously selecting either operation:—(1) The size, long standing, previous attacks of incarceration and obstruction of the hernia, all these tending to bring about adhesions and alterations in the parts. (2) The condition of the patient—viz., the degree of flabby fatness, chronic bronchitis, probable renal and hepatic disease, amount of depression by vomiting and pain. (3) The facilities for carrying out during the operation, and, later, strict aseptic precautions. (4) The presence of the skilled help so essential in these cases. (5) The way in which the anæsthetic is taken. (6) The amount of experience of the operator. Thus a hospital surgeon, frequently operating and with all instruments and assistance at hand, may readily incline to one course, while the other may as wisely be followed by a surgeon who has to operate under very different circumstances.†

STRANGULATED OBTURATOR HERNIA.

This form of hernia has occurred too frequently to be entirely passed over. It may be so readily and fatally overlooked that a few words on its *diagnosis* will not be out of place.

(1) Position of the swelling. This appears in the thigh below the horizontal ramus of the pubes, behind and just inside the femoral vessels, behind the pectineus, and outside the adductor longus. (2) On careful comparison of the outline of Scarpa's triangles, a slight fulness is found in one as compared with the hollow in the other. (3) Pain along the course of the obturator nerve, down the inner side of the thigh, knee, and leg. (4) Persistence of symptoms of strangulation, the other rings being empty or occupied by reducible hernia. (5) A vaginal or rectal examination.

Operation.—Two different ones present themselves: (i) by cut-

* It will be remembered that it is not as essential to try and ensure a radical cure in the usual subjects of umbilical hernia as in children and young male adults, with the prospect of a long and active life before them.

† Mr. Clement Lucas (*Clin. Soc. Trans.*, vol. xix. p. 5) advocated more radical measures, such as excision of the sac and redundant skin, with suture of the ring, in all cases of umbilical hernia. Two successful cases are recorded, both excellent instances of this treatment, and one of especial interest, as the patient had been previously thrice tapped for ascites, and the operation allowed three pints and a half of fluid to escape.

ting down on the sac as in other herniæ; (ii) by abdominal section, and withdrawing the loop from within.

(i) The parts being duly cleansed and slightly relaxed, an incision is made parallel to and just inside the femoral vein.* The saphenous opening being probably exposed in part, the fascia over the pectineus and the fibres of this muscle having been divided transversely for $1\frac{1}{2}$ or 2 inches, the obturator muscle covered by its fascia and some fatty cellular tissue is next defined, and the hernial sac probably now comes into view, either between the muscle and the pubes, or between the fibres of the muscle. If the case is a recent one, attempts are now made to reduce the hernia without opening the sac. If the sac has to be opened, and any constriction divided, the knife should be turned either upwards or downwards, the latter being the easier if any constricting fibres intervene between the sac and the bone. As the obturator vessels lie usually on one side or the other, a lateral incision must be avoided.

Care must be taken to keep the femoral vessels drawn outward with a retractor, while any branches of the obturator or anterior crural nerve are drawn aside with a blunt hook, the same precaution being taken with the saphena vein.

When by the passage of the little finger into the abdomen it is certain that the intestine is reduced, if the condition of the patient admits of it, the sac is separated and ligatured close to the thyroid foramen and removed. Drainage must be provided with aseptic horsehair or a fine tube.

(ii) The operation of abdominal section will, perhaps, be more frequently performed in the future.

An obturator hernia was thus reduced by Mr. Hilton in a case which simulated intestinal obstruction. Some empty intestine being found and traced downwards, led to the detection of an obturator hernia, which was reduced by gentle traction aided by firm pressure made deeply in the thigh. The patient, who was not operated on till the eleventh day, died of rapid peritonitis.

Sir J. E. Erichsen briefly mentions a case operated on by this means in 1884 by Mr. Godlee. The hernia was reduced without difficulty, but the patient, who was much collapsed at the time, died in about twenty-four hours.

Question of the advisability of reducing Strangulated Hernia by Abdominal Section.

This question having arisen here may be dealt with once for all. Cases will occur from time to time, as in Mr. Hilton's (*loc. supra cit.*), in which evidence of acute intestinal strangulation existing and no hernia being detected externally, on the abdomen being opened, the cause will be found to be a piece of small intestine nipped in part of its circumference, probably in either one of the femoral or obturator rings. Still more rarely, a surgeon may find such difficulty in reducing an obturator hernia from without, that he

* Mr. Birkett (*loc. supra cit.*, p. 830) says the incision "may commence a little above Poupart's ligament, at a point midway between the spine of the pubes and the spot where the femoral artery passes over the ramus of that bone."

feels himself driven to resort to abdominal section. In such a case an incision should be made along the corresponding linea semilunaris, and brought as low down as possible. When the abdomen is opened, if there is any difficulty in withdrawing the gut, the intestines should be pushed upwards out of the pelvis, and the neighbourhood of the ring shut off with sponges or iodoform gauze-tampons, while the condition of the strangled loop is inspected, and this either reduced or treated by resection, or the making of an artificial anus, according to the condition of the patient and the surroundings of the operator. Of late it has been suggested that it should be the rule to reduce herniæ, and perform the radical cure by abdominal section. Thus, at the meeting of the British Medical Association in 1891 (*Brit. Med. Journ.*, Sept. 26, 1891), this question was discussed, Mr. Lawson Tait introducing the subject. As might be expected, the proposal to abandon the old operation and treatment by median abdominal section met with no support from those surgeons who know anything of operations for strangulated hernia in hospital practice, especially in males. Save in the rarest cases, such as those belonging to the category I have mentioned, such a step is to be condemned in the strongest terms, for the following reasons: (1) Operations for relief of strangulated hernia must sometimes be performed by general practitioners. The old and well-established operation is one, *per se*, of but slight severity, and one that usually can be kept extra-peritonæal by an operator of ordinary skill and of average anatomical knowledge. Those who would substitute abdominal section forget that however safe they may consider themselves with their especial experience to be in preventing *peritonitis*—a very different standpoint from that of a general practitioner—neither they nor any one else can prevent the *shock* which goes with intra-peritonæal operations, a complication which is certainly to be avoided in patients exhausted by a strangulated hernia. (2) The reduction of the intestine which is spoken of as so easy after abdominal section by those who advocate this method is liable to be prevented by adhesions to the sac, &c.; when such exist, and no one can foretell this point, the sac must be explored in the usual way. (3) There is a very grave risk that the intestine is tightly nipped, and often may give way when pulled upon through a median incision. Those who advocate abdominal section will say that the resulting extravasation can be met by flushing, &c. It will be well for all such to remember the following advice, tersely put by Mr. Bennett (*Clin. Lect. on Hernia*, p. 122): “Let it be noted that it is generally far more easy to *soil* the peritonæum than to *cleanse* it.” The same surgeon points out (*ibidem*, p. 121), that the fluid found in the sac of herniæ when strangulation has long existed, is sometimes dark and ill-smelling, though no lesion may be apparent in the gut itself. By an ordinary herniotomy such fluid is thoroughly drained away from the peritonæal cavity, and any such intestine is cleansed before it is put back, or otherwise appropriately dealt with. (4) All

operating surgeons are agreed that whenever the condition of the patient admits of it, an operation for strangulated hernia should be completed by giving the patient at least a chance of radical cure. I am distinctly of opinion that no intra-peritoneal operation yet described will secure radical results in inguinal herniæ. (5) Those who think they are improving matters by substituting abdominal section for the old-established herniotomy, object to the latter on account of its tendency to weaken the abdominal wall by the incision made to reach and relieve the constriction. Such advocates forget the criticism pithily put forward during the above discussion by Mr. Keetley, that treatment of herniæ by abdominal section created two potential hernial apertures where there was originally but one.*

RADICAL CURE OF HERNIA.

Before describing the different methods, the following points claim attention, and while the improvements of modern surgery have established radical cure on a sound scientific basis, many questions remain still undecided. The chief of these are:—(1) The justifiability of the operation. (2) The use of the terms, “radical cure” and “permanency of the cure.” (3) The earliest age at which the operation is advisable in children. (4) The advisability or need of wearing a truss afterwards. (5) The best material for suture. (6) The best form of operation.

(1) **The justifiability of the Operation.**—Before we can answer this in the affirmative we must be able to honestly feel that the operation is safe, (a) *as regards the patient's life*, (β) *as regards the testicle*. Only those surgeons who have had experience in operating, who are thoroughly acquainted with the needs of modern surgery, and who will pay the needful attention to every detail can promise the above safety.

(a) *The safety of the patient's life.* The following recent statistics show what modern surgery and experienced hands can do. Prof. Macewen has operated on 104 cases of radical cure for oblique inguinal hernia with only two deaths, both in children, one from scarlet fever, the other from measles and meningitis. Dr. Coley of New York (*Ann. of Surg.*, April 1895, p. 391) has operated on 160 cases of inguinal hernia by Bassini's method, with only one death, one to a double pneumonia on the eighth day. And did space allow, many other excellent results might be given. (β) *The safety of the testicle.* This is dealt with at p 657.

* The question of herniotomy or abdominal section will also be found raised by Mr. Lupton in the *Lancet* for May 9, 1891. Of the two cases he relates, one is an instance of that rare form of acute intestinal obstruction, due to a piece of small intestine nipped in part of its circumference in the right femoral ring. The other case—which is very obscure from the scantiness of details of the autopsy—is still more far too exceptional to justify resort to abdominal section as a routine practice in preference to the old-established herniotomy.

(2) **The value of the term Radical Cure, and the Permanence of the Cure after Operation.**—Present results give the promise of great improvement here. A few years ago some of the best authorities here were not using the term "radical." Thus Mr. M. Banks, one of the earliest and foremost workers on the subject, and a writer who has given his results with honest frankness, considers the term radical cure "misleading. It is popularly understood that a patient upon whom the radical cure has been performed, need never again wear a truss nor ever again be in danger of his hernia coming down. This is, unfortunately, far from being the case. The instances in which a light truss can be dispensed with are in the minority." A few years later (*Brit. Med. Journ.*, 1893, vol. ii. p. 1044) Mr. Banks wrote somewhat more hopefully. Of 168 cases he had traced for very considerable periods 113; "of these 79 remain quite sound, 19 are partial successes, and 15 are complete failures." In America—where, as with oophorectomy and removal of the appendix, this operation has been resorted to more freely than in this country—warnings have been given by some of the best known surgeons that the use of the term "radical cure" may be premature. Amongst the chief of these has been Dr. W. T. Bull,† Surgeon to the Hospital for the Ruptured and Crippled of New York. Dr. Bull has collected 137 cases operated on for radical cure in which a relapse had taken place, and he adds that these relapsed cases "probably represent but a small proportion of those operated on."

Mr. Macready, Surgeon to the City of London Truss Society, writes the following weighty words on what he calls the unsatisfactory nature of the evidence as to efficacy of the radical cure (*A Treatise on Ruptures*, p. 234): "The evidence brought forward by one surgeon after another in favour of these operations is always of the same character. A number of cases are given in which the operation has been performed, and in which the result has been watched for periods varying usually from a few months to four or five years. Very few cases are under observation so long as five years. For the patient changes his residence or declines to show himself. M. Terrier on one occasion wrote to twenty-five old patients, and received only two replies. It must not be supposed that a patient is cured because he does not come for inspection. The relapsed cases at the Truss Society have almost all been asked if they have visited the operator to show him the result. In the great majority of cases they prefer not to go back, and very often, alas! express themselves as if a deception had been practised upon them. It is much to be regretted that patients should feel this reluctance to face the operator again, for in consequence the surgeon is apt to form too favourable an opinion of the efficacy of his plan. Sometimes a patient after remaining cured for a number of years

* Pamphlet; *Med. Times and Gaz.*, 1884; *Brit. Med. Journ.*, Dec. 10, 1887.

† *N. Y. Med. Journ.*, May 30, 1891; *Med. News*, 1890; *Annals of Surgery*, 1893, vol. i. p. 534 *et seq.*

passes from under observation and again becomes ruptured. . . . All that we can say of the operations, involving complete removal of the sac, is that they all give immunity to a certain number for a certain time."

While opinions like the above, candidly expressed by surgeons of wide experience, will carry special weight with all thoughtful surgeons, it is probable that the work of the last few years, and still more that of the coming decade, will place the radical cure of hernia on a firmer and more satisfactory basis.

We are now learning more distinctly the principles on which this operation is to be conducted. Two or three methods have now been employed on such a large scale, and with such excellent results, that it seems probable that a permanent cure can be promised in a large number of favourable cases. This qualified statement requires explanation. By a permanent cure, I mean a cure which will last a lifetime. By "favourable cases," I mean children, young subjects, herniæ of moderate size, where the rings and canal are still present and not stretched and converted into one large direct gap into which the tips of two or three fingers can be easily placed; cases where the patients operated on have sense enough to give the newly repaired structures sufficient rest for their consolidation, and where, if they must follow employment or exercise that involve much straining, they will give the parts the support of a truss of light pressure or a belt* (*vide infra*). If this is not done we shall see, if cases are carefully followed up and candidly reported, that radical cures will not last a lifetime, and that the term will have to be largely replaced by the following, according to the degree of cure obtained—viz., "complete successes," "partial successes," "complete failures."

For cases to be reported as really successful it will be needful to follow them up for a much longer period than has hitherto been the case. In studying such lists as those published by Coley (*loc. supra cit.*), in which it is claimed that of the 160 cases of inguinal hernia operated on by Bassini's method with kangaroo-tendon for a buried suture not a single relapse occurred, in a very large number of the cases the "final result, perfectly sound," is recorded within six months of the operation. Such results, while proving the safety of the operation for the life of the patient and encouraging for the future, are not to be taken as proving that a really radical cure can be secured by the method given. It is to be feared that such reporting of cases may be actually misleading by causing much less competent operators to think lightly of the operation, and to be over-sanguine in promising results.

* Many will say that if any truss or support is worn afterwards the cure is not radical; I admit this, but reply that until published series of cases have been watched for a much longer period, we shall, as relapses may occur five or eight years after operation, do wisely to advise our patients to support the restored region with a well-fitting truss of light pressure, and so bring about a permanent cure instead of a liability to relapse.

It is noteworthy that with regard to this premature publication of results that cases of very late relapse have been noticed when the patient has been left long under observation. Thus one occurring at a period of four and a half years is noticed by Dr. Bull (*Ann. of Surg., loc. supra cit.*, p. 535). The case had been operated on by Dr. R. F. Weir by Macewen's method. Here Dr. Weir's name and the time that had elapsed between the operation and the recurrence are sufficient guarantees that the operation had been properly done. In another case eight years had elapsed.

From the above it is clear that when consulted as to the performance of a radical cure by patients the subject of hernia, they can be assured as to the safety of the operation and the probable permanence of the cure in favourable cases (*vide supra*). Furthermore, it is certain that if a relapse should recur the majority of patients will be better off than before the operation. The protrusion that appears will be smaller than the original rupture, more readily kept within bounds like a bubonocoele, and a truss will be worn with greater comfort. On the other hand, if suppuration occur, and a thin-walled feeble cicatrix, sure to yield increasingly as years go on, is the only result, the outcome of the operation may leave the patient worse off than he was before.

A question that often arises relates to the wearing of a truss and the possibility of the hernia being cured by this means alone.

The answer deciding between the wearing of a truss and an operation for radical cure will depend greatly on the mind of the surgeon consulted. If he is one of those (I confess I am of the number) who believe that this operation is too indiscriminately resorted to, he will hold that no operation, save for special reasons (*vide* Indications for Operation), is to be advised where the hernia can be kept up by a truss, that a light and well-fitting truss is not the bugbear it is too often made out to be by those who advocate operation as the rule. It would be well if surgeons would spend some of that pain and trouble in ensuring that the truss fits, before it is thrown aside, which they give to inventing or modifying operations for radical cure, and if patients would exert a little more trouble and pains in getting a proper and well-fitting truss at a duly qualified instrument-maker's, instead of the first cheap trash which they see in a chemist's shop. I have pointed out below, under the heading Indications for Operation, the cases where this question of wearing a truss does not arise.*

When this question, whether the wearing of a truss will effect a radical cure arises, in the case of infants and children, these cases may be divided into the following groups. In one, and this is the largest of the three, the careful wearing of a truss by a child will permanently cure the rupture. In a second group, a large one, the

* An ill-fitting truss is, of course, worse than useless and may mat together the tissues.

hernia, though not cured, will be perfectly controlled with very slight inconvenience to the patient. In the third, a very small one, there is no tendency to spontaneous cure even when a suitable truss has been diligently worn.

On this follows naturally the next question: **What is the earliest stage at which an operation should be performed?** Below I have stated my opinion that while it is occasionally justifiable to operate in the second year of life, where a persisting hernia is large, it is as a rule better to defer operation till the age of four or later.

4. **The Advisability or Need of Wearing a Truss afterwards.**—The tendency of the present day to condemn offhand or to deprecate strongly the use of a truss after an operation for radical cure is, I think, a great mistake. Each case must be judged separately. With regard to children, from an experience of my cases, I think that if the recumbent position be insisted on for three months after the operation, so as to give the newly restored parts time to consolidate firmly, a truss will not be subsequently required, so great is the tendency to repair in early life. Umbilical herniæ I am inclined to make an exception. The communication which has here been closed has been relatively so large, the stress thrown upon it after repair in expiratory efforts (as when the child cries every time at the approach of the surgeon or dresser during the after-treatment) is so direct, that the scar should, I think, have support for some time in the form of a well fitting belt.*

In adults the objection usually made to a truss is that its pressure will produce absorption of the scar. While it will be granted at once that any continuous pressure in the form of a pad with a strong spring will tend to weaken and remove the inflammatory thickening resulting from the operation, I am distinctly of opinion that some well fitting slight support in the form of a truss or belt should be worn in the following cases—viz., where the abdominal walls are very fat, flabby and pendulous; where there is heavy work either done continuously or by fits and starts; where any silk has worked out or where the wound has healed by suppuration (*vide supra*, p. 652); in some cases where the radical cure has been done after an operation for the relief of strangulation, and the surgeon has perhaps been hurried, or has operated at night, and, of course, in cases where there is any return of the hernia. Other cases are umbilical herniæ both in adults and children for the reason I have given above, in femoral herniæ, owing to the difficulty, in many cases, in doing more than twisting, tying or inverting the sac (p. 676), and also because the sex and dress of the patient usually makes the wearing of a truss less irksome. On the other hand, in early congenital cases, in boys, in young adults without laborious work, or where the reparative power is good, where sufficient rest has been taken after the operation,

* Any phimosis or cough should be of course treated.

and where primary union has been secured and remains firm, no truss need be worn. But the importance of intelligent supervision at intervals should be insisted upon.

The presence of a cough, carelessness about constipation or a stricture will of course be duly weighed, and I may remind my readers of a warning uttered at p. 652, that relapse may take place as late as four or even eight years after a skilfully performed operation.

The best form of Suture.—Though hitherto I have used silk, I am of opinion that kangaroo-tendon, if a suitable specimen, duly sterilized, can be obtained. will be found preferable, and I intend to make trial of this in future. Silk is most satisfactory to work with at the time, it can be obtained at once, it is soon sterilized, it is strong, and it lends itself readily to easy tying and a secure knot. But the after-result is, in my opinion, less satisfactory, owing to its liability to come away, often persistently. There is a tendency to believe and teach that wherever silk comes away after an operation, it must always be due to some deficient sterilization of the silk, or to some failure to keep the wound aseptic. While these are leading causes, they are not, I am persuaded, the only ones, the site and the character of the tissues concerned play a very important part. Inside the peritonæal cavity, where the ligature lies deep and is surrounded by a serous membrane as in an ovarian pedicle, we are certain our silk ligature will give no trouble; in ligature of the carotid or femoral artery, where the ligature also lies deep and is surrounded by vascular structures, we have rarely trouble with our silk ligatures, but here, where any silk used lies comparatively superficially and embedded in fibrous tissues such as the conjoined tendon or Poupart's ligament, its surroundings are so different that a surgeon need not always blame himself for deficient asepsis, or faulty tying when his silk comes away. I am aware that many surgeons, higher authorities than myself, claim that silk, wire, salmon-gut can all be used as buried sutures without any further trouble. In a certain and large proportion I know from experience that silk can be used, but in a considerable number this and the other materials most certainly cause trouble later on. The wound runs an aseptic course, heals without suppuration, and then, after a varying period, a sinus appears, and one or more of the sutures have to be removed. Prof. Macewen uses chromicized catgut, prepared by himself. Dr. Coley in the paper referred to above, used kangaroo-tendon in 160 cases, and though the interval between the date of operation and that of publication is in very many of them far too brief for the cure to deserve, in my opinion, the term "radical," the constancy with which primary union was secured speaks very strongly, I think, for the use of kangaroo-tendon in preference to silk, and I intend to give the former material a trial.*

* Whatever material be employed it must be sterilized by the surgeon himself, and not left, haphazard, to others.

Indications.—The following are given only as types of appropriate cases. Many others will suggest themselves :

i. Cases of irreducible hernia where other treatment has failed, where an active life is interfered with, or where attacks of inflammation have occurred, or strangulation threatened. Subjects of inguinal hernia with adherent omentum are never really safe, especially if of active life : from this, however, they are usually debarred. Femoral hernia containing irreducible omentum should also be operated on. These herniæ are difficult to fit with trusses ; the omentum keeps the ring open, and thus paves the way for the descent of bowel on any sudden exertion. Where irreducible herniæ are small, and the adhesions easily separated, very great relief will be given the patient with very slight risk. But it is otherwise where the sac is very large, or the contents very adherent, especially about the neck of the sac. In either case the risk of peritonitis is considerable, in the one case from the direct opening into the peritonæal cavity which may be present, the large amount of contents which have to be manipulated, and the difficulty of keeping the operation extra-peritonæal. Again, intricate adhesions about the neck of the sac may either lead the surgeon to abandon the operation, or to lay open the abdominal wall in order to deal with them. This last step not only increases the risk of peritonitis at the time, but may bring about some time later a hernia very difficult of control, the ultimate improvement in the patient's condition being thus of a very limited nature.

ii. Cases of strangulated hernia, where the patient's condition admits of the operation being prolonged.

iii. Cases where a hernia is not controlled by a truss, but slips beneath it. Such cases should be extremely rare if patient and surgeon alike showed sufficient pains and patience in securing a well-fitting truss.

iv. Cases of hernia with ectopia testis where the fitting of a truss to keep the hernia up and the testicle down fails. Castration should always be performed when the condition of the testis is useless or doubtful.

v. Cases where the hernia can be controlled by a truss, but the use of this is irksome to a patient of very active life, where he wishes to join the army or navy, or where he may, as a colonist, be far removed from surgical help.

vi. Children of poor, ignorant, and incompetent parents, with large herniæ, where proper attention to the use of a truss cannot be secured, or where the persevering use of this has failed, and where all such causes as phimosis, cough, &c., have been removed. It will probably be justifiable to go further than this, and to operate for radical cure in most cases of herniæ in the children of the poor in which the hernia is still large at four to six years of age.* By this time the parts are better developed and more

* This age is mentioned above as giving time for sufficient trials with a truss.

easily kept aseptic. The sac is more easily dealt with now than later. The presence of any conditions which call for exploration—viz., hydrocele, adherent omentum, the presence of the appendix—will also be indications for operation in children. On this point, operation for radical cure in little children,* I will quote Mr. Macready (*loc. supra cit.*, p. 256). We may all envy his especial experience and strive to imitate his skill. “Uncontrollable ruptures in children under fifteen are very rare; to me, indeed, they are as yet unknown. I hope it does not imply any lack of charity to say that one can measure with fair accuracy a surgeon’s skill in the management of trusses by the number of curative operations he performs on children.”

vi. Large herniæ, even colossal, where the patients, unfitted for work of any kind, are a burden to themselves and others,† and perhaps willing to run great risks; for it cannot be denied that these are very grave cases: “The operation usually difficult and prolonged, and the dangers to be met and overcome both numerous and various” (Banks). The chief of these is the direct and gaping communication with the peritonæal cavity and the difficulty in keeping the operation extra-peritonæal. The best proof of this is given by Mr. Banks’s series of 16 very large and enormous herniæ; of these he lost 4, 2 from septicæmia. In another, even his hands failed to complete the operation.

viii. I consider ten to twenty-five years of age as the most favourable time, as combining parts easy to handle, the possibility of keeping the wound aseptic, probable absence of any difficult adhesions, and good vitality and health.

Choice of Operation.—The following have been brought prominently before the profession, viz.:

i. **Operation by Open Method with Strict Aseptic Precautions.**

ii. **Subcutaneous Methods**—*e.g.*, Prof. Wood’s and Mr. Spanton’s.

iii. **Injection of Astringents**—*e.g.*, Oak-bark.

Of these, the operation by open method will only be described, as it is the one of all others which is generally chosen, owing to the excellent results which it has given, the precision with which the structures concerned can be avoided or manipulated, and its safety when aseptic precautions are strictly observed.

i. **The Operation by Open Method with Strict Aseptic**

* Before deciding that a well-made truss will not keep up a difficult case—*e.g.*, a double inguinal hernia—the hernia should be completely reduced with the aid of an anæsthetic.

† As in three cases given by Mr. Banks: one, a labourer, unfitted for work had become an inmate of a workhouse; the second was a wine-merchant, who had been obliged to give up his business, rarely venturing out, and then obliged to conceal his deformity under a large overcoat; the third, a glass-blower, reduced to perfect helplessness, had to depend on his wife for his support.

Precautions.*—The patient having been kept in bed for some time before, according to the size of the hernia, and any cough attended to, only liquid diet is given for the few days preceding the operation, and the bowels are duly emptied.

Before describing the different methods mostly in vogue, I will allude, for the sake of my younger readers, to a few points which are always of importance whichever method is selected.

The parts being shaved if needful, and cleansed,† the thigh being a little flexed, an incision is made with its centre over the external abdominal ring.

This divides skin and fasciæ and several branches of the external pudic arteries; these should be secured with Spencer Wells' forceps, which will also open out the wound. In young males, especially, where these vessels are of considerable size, care must be taken that each point is firmly closed either by the forci-pressure or catgut ligature; otherwise free bleeding may readily take place in the lax tissues of the groin, preventing primary union, and perhaps leading to most troublesome tension and suppuration. The aponeurosis of the external oblique and the cremasteric fascia having been next divided, the site of the cord is made certain of, and the sac most carefully defined. This if empty is by no means always easy, especially in young subjects. In defining the sac, care should be taken to work carefully and without any needless disturbance of the parts, or separation of the planes of tissue here met with. So, too, with the cord—great care must be taken in the next step when the sac and this structure are separated; hasty work may lead to needless hæmorrhage from ruptured veins, injury to the sac, or subsequent epididymo-orchitis, and even sloughing of the epididymis with part of the testicle. The sac having been accurately defined, is opened so that an aseptic finger may make sure that it is empty, otherwise any intestine is completely reduced or omentum dealt with according to the steps given at p. 630. If the question arise, whether the sac should always be opened, I should answer "Yes." Even if it appear empty below, it is satisfactory to be assured by an aseptic finger that nothing lies within the neck before this is twisted or tied as high up as possible. A case of Busch's (*Med. Klin. Woch.*, 1882, No. 31, p. 473) shows the importance of taking this step.

Operating on a boy $2\frac{3}{4}$ years old for a right inguinal hernia, Busch tied the sac before opening it. When it was cut into below the ligature the vermiform appendix was found included. This was released and returned. Some time later Busch was operating on the left side and again found that he had included the appendix in his ligature round the sac.

When the emptied sac is next separated from the cord

* The following remarks apply to inguinal hernia.

† Dr. Macewen (*loc. infra cit.*) recommends scrubbing with a nail-brush and soap and water; after drying, turpentine, to remove any grease, and then a little methylated spirit to clear away the turpentine; the parts being then covered with an aseptic compress.

and adjacent parts,* care must be taken, if the patient strain at this time, that no escape of intestine occur, an assistant maintaining pressure over the internal ring. The cord must be treated with the precautions given above, and care must be taken that the testicle is not dragged needlessly out of its bed. The sac is now treated, and the canal closed by one of the methods given in detail below ; if the sac be very adherent below, this part should be left *in situ* ; if it be unusually thick and bulky, part may be cut away. When the condition of the patient, the way in which the anæsthetic is taken, &c., are favourable, the pillars of the external ring (these lie deeper than beginners might expect) may be defined, and this aperture closed with medium-sized sutures of kangaroo-tail or silk. But if the canal has been securely closed by sutures introduced after Macewen's method, closing the external ring is superfluous ; by itself it is futile. The wound having been thoroughly dried out, and some Jeyes' powder or iodoform dusted into its recesses, it is closed with sutures of salmon-gut or silk, care being taken that no inversion of the edges is present, and, of far more importance, that all hæmorrhage has been entirely stopped, including those points from which Spencer Wells' forceps have been removed. If absolute dryness of the wound has been secured, and the operation has been aseptic throughout, no drainage is needed. A slip of green protective out of carbolic acid lotion 1 in 20, and some strips of iodoform gauze wrung out of the same, are then placed next the wound, and covered by any of the aseptic gauzes or wools. It is well worth while to keep the scrotum well up on the pubes, and thus minimise the risks of œdema of the scrotum and epididymo-orchitis.

To the above general remarks I have only to add that it is always well, when the radical cure is performed in patients with long-standing hernia (with important parts and the sac perhaps very adherent) or a voluminous one, for the operator to obtain leave beforehand to sacrifice the testicle ; and the same course will be taken when a retained testicle is found to be probably functionless. If it is worth while to fix this again in the scrotum, this should be done according to the steps given under the heading of Orchidopexy.

Any child or restless patient should be secured in a long outside splint ; finally, if any stitch-sinus appear, that part of the wound should be well scraped out at once, and made to heal from the bottom. Sometimes it may be advisable to give A.C.E. mixture at the first dressing.

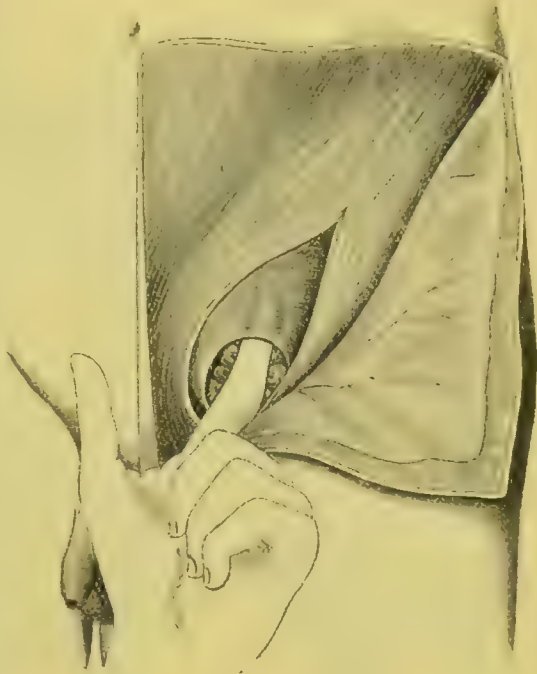
The different methods which are chiefly in vogue will next be described, and first of these I place Macewen's, from the excellent results which it has given, the sound reasoning on which its principles are based, and the widely known reliability of the work and teaching of the inventor.

* If much difficulty is met with here, the surgeon should begin high up, as near the internal ring as possible, dividing the external oblique aponeurosis.

(i) *Macewen's** (Figs. 152 to 158).

The object of this is twofold: (1) So thoroughly to separate the sac as to allow of its being completely reduced into the abdominal cavity, there to rest on the inner surface of the ring, and acting as a bulwark-like pad to "shed the intestinal waves away" from it. Prof. Macewen thinks that if the sac be merely tied, however carefully and high up this is done, there remains a funnel-shaped puckering, the apex of which presents in the internal ring, and that this pouch gradually becomes a wedge, tending to open up the canal.

FIG. 152.



Macewen's operation. The index-finger, inserted along the inguinal canal, is separating the peritonæum from the internal aspect of the internal ring. The folded sac is behind. In this and the following figures a flap of skin and cellular tissue has been reflected, and the external oblique opened up so as to expose the canal and internal ring.

Thorough separation of the sac, and carrying this well within the peritonæal cavity, is absolutely needful, for if the sac be left in the canal, it will act as a plug keeping it open. (2) Again, to close the dilated canal and restore its natural valve-like condition by a particular mode of inserting sutures which bring the conjoined tendon in close apposition with Poupart's ligament, beginning with that part of the ligament which is on a level with the lowest part of the internal ring.

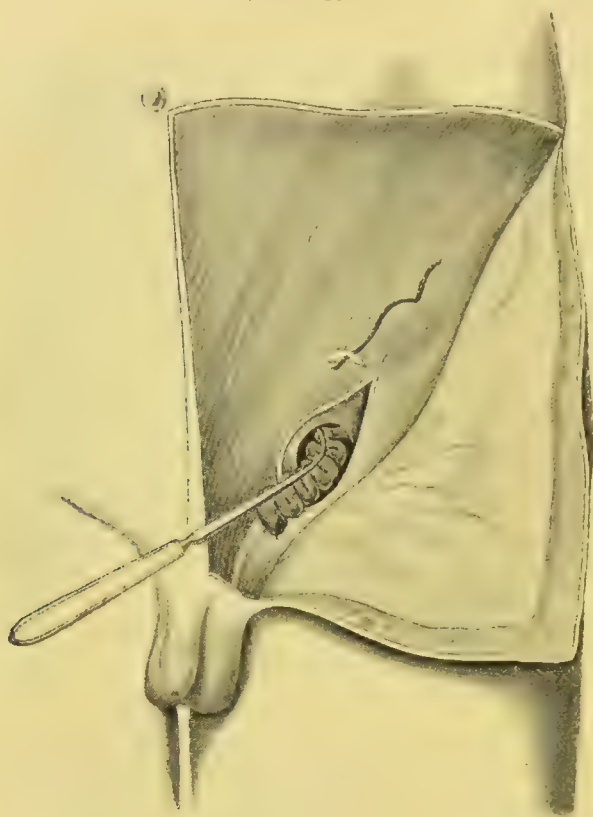
The first object is thus ensured:—The external ring being exposed (after the preliminaries, footnote, p. 657), the internal ring and site of the deep epigastric are examined, and the sac next freed and raised. When this is done it is kept pulled down while the index-finger separates the sac from the cord, the canal, and finally for $\frac{1}{2}$ inch around the abdominal aspect of the internal ring.† Fig. 152). The sac is now folded on itself (Figs. 153, 154) by means of a stitch which is firmly fixed in the distal end of the sac. The free end, threaded on a hernia-needle (Fig. 154), is introduced through the canal to the abdominal aspect of the fascia transversalis, and there penetrates the abdominal wall

* *Ann. of Surg.*, August 1886; *Brit. Med. Journ.*, December 10, 1887.

† The object of this is to refresh the abdominal aspect of the internal ring, so that adhesions may form between it and the pad of sac.

about 1 inch above the internal ring (Fig. 153). The wound in the skin is pulled upwards,* so as to allow the point of the needle to project through the muscles without penetrating the skin. The needle being withdrawn and unthreaded by traction on the thread, the folded sac is drawn still further backwards and upwards. Traction having been kept up on the thread while the sutures closing the canal are introduced, it is finally secured by passing it several times through the external oblique muscle.

FIG. 153.



Macewen's operation. The hernia needle is carrying the suture, threaded through the sac, through the abdominal muscles, from behind forward, about an inch above the internal ring.

the suture is then withdrawn, and then the needle, with the other end, is removed. Thus, a loop is left on the abdominal aspect of the conjoined tendon, which is penetrated twice (Fig. 156).

Secondly, the other hernia-needle, threaded with that part of

The second part of the operation, closure of the inguinal canal, is now undertaken. The finger, passed into the canal and lying between the inner and lower border of the internal ring in front of and above the cord, makes out the position of the deep epigastric artery so as to avoid it.

The hernia-needle, carrying chromic gut, then, guided by the index, is made to penetrate the conjoined tendon in two places: first from without inwards near the lower border of the conjoined tendon, and secondly from within outwards, as high up as possible in the inner aspect of the canal; this double penetration of the conjoined tendon being accomplished by a single screw-like turn of the instrument (Fig. 155). One end of

* Beginners will find it best to divide the aponeurosis of the external oblique, and so obtain sufficient room for rightly dealing with the sac. This requires an additional row of sutures, and may weaken the abdominal wall. On the other hand, beginners will always find it difficult, however much the upper angle of the wound is pulled up, to get the sac detached really high up, and to put the needful sutures into the conjoined tendon with the limited incision which is sufficient for the experienced hands of Prof. Macewen.

the suture which comes from the lower part of the conjoined tendon, guided by the index in the inguinal canal, is passed, from within outwards, through Poupart's ligament, which it penetrates at a point on a level with the lower suture in the conjoined tendon (Fig. 157). The needle is then completely freed from the suture and withdrawn.

Thirdly, the needle, now threaded with that part of the catgut which protrudes from the upper border of the conjoined tendon

FIG. 154.

FIG. 155.



On the left is one of Prof. Macewen's needles.* They are made of one piece of steel. To the right is the sac, transfixed and thrown into a series of folds by a thread which should be shown emerging above as well as below.



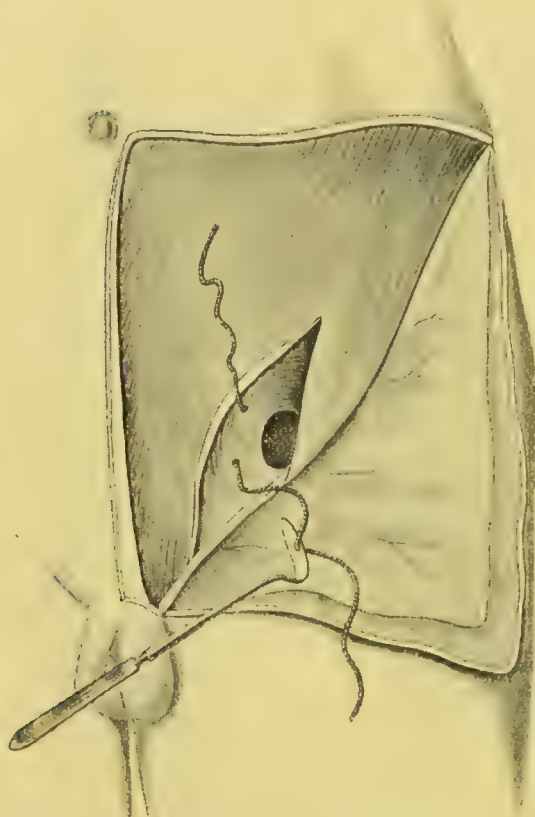
Macewen's operation. A hernia-needle (loaded) has been made to penetrate the conjoined tendon in two places.

is passed from within outwards through the transversalis and internal oblique muscles and the aponeurosis of the external oblique at a point on a level with the upper stitch in the conjoined tendon. It is then quite freed from the suture and withdrawn. There are now two free ends in the outer surface on the external oblique, continuous with the loop on the abdominal surface of the conjoined tendon (Fig. 158). The two free ends being drawn together tightly, and tied as a reef-knot, the internal ring is firmly closed. The same stitch may be repeated lower down in

* These are two in number, one for passing the thread from right to left, and the other from left to right. I have found Mr. Watson Cheyne's modification of the above needles, in which the instrument is angular instead of curved, much more convenient for picking up the conjoined tendon and external oblique.

the canal, especially in adults, with wide gaps. The pillars of the external ring may likewise be brought together. In the great majority of cases the first or uppermost stitch is all that is required. The cord should lie behind and below the sutures and be freely movable in the canal. It is advisable to introduce all the sutures before tightening any of them. They may then be experimentally drawn tight while a finger is introduced into the canal to learn the result. During the operation the skin is drawn from

FIG. 156.



Macewen's operation. A loop has been left on the inner surface of the conjoined tendon.

side to side to bring the parts into view. The skin falling into position, the wound is opposite to the external ring, the operation being partly subcutaneous.

In congenital hernia the sac is first separated from its connection with the canal. It is then opened and divided transversely into two parts, care being taken to preserve the cord. The lower part forms a tunica vaginalis. The upper is pulled down as far as possible, split behind longitudinally so as to allow the cord to escape, and its lower end closed by a stitch or two. It is then dealt with quite as the sac of an acquired hernia.

The above method, soundly based on accurate anatomical and physiological reasoning, admirably fulfils the two conditions needful for every operation for radical cure of

hernia—viz., the permanent blocking of the abdominal opening, and the safe closure of any canal outside.

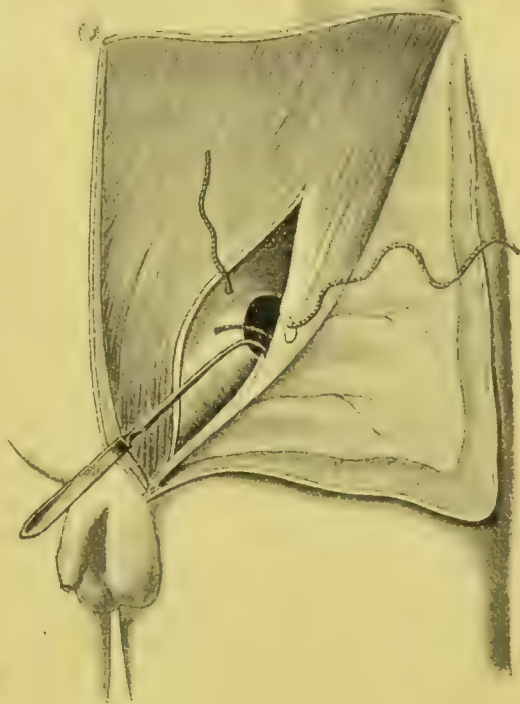
The following points deserve attention.

The method has been objected to as complicated and difficult, and as inapplicable to infants on account of the difficulty of making out any conjoined tendon at this age. The above objections will disappear with practice. As Prof. Macewen has stated, a skilled finger will detect the conjoined tendon even in early life. Smaller needles must, of course, now be used. Other difficulties are met with in this method when the sac is unusually coarse and thick, or when it is extremely thin; such sacs are no doubt difficult to manipulate satisfactorily, and in getting the pad well within the internal ring.

Professor Macewen has kindly forwarded to me this recent statement (July 1895) as to his results:

"I have had 164 completed cases of operation for oblique inguinal hernia. Regarding radical cures, one must necessarily be guarded in drawing conclusions when dealing with large numbers, as many of the patients pass from observation, and though asked to report themselves, do so only a few times, and then cease. Thus out of 164 there are 55 who have dropped entirely out of view. Many of these had previously been seen three to nine months after operation, when they

FIG. 157.



Macewen's operation. The thread from the lower part of the conjoined tendon has been carried through Poupart's ligament.

FIG. 158.



Macewen's operation. Two of the threads which are to draw the conjoined tendon over to Poupart's ligament are in position ready for tying.

the seat of the former hernia. He now has a bubonocoele. The other was two years free from hernia, and then had a slight rupture. Each of those wear belts—light ones, which retain the hernia even during their work. A third remained well for two

had firm occlusion of the abdominal wall. Two children died after the operation—one from scarlet fever, epidemic at the time, and one from measles and meningitis, the latter rather a weak child. This leaves 107; of these, five are known to have had return. Two of these were steel workers, doing the heaviest kind of work. One was cured during eight years, and then a slight bulge appeared near

years, then had an attack of what was stated to be enteric fever, and subsequently became affected with tubercle of the lungs. He had a distinct recurrence of the hernia. A fourth I have heard of as having a return to a slight extent, and a fifth wrote to say that he had a return.

If we strike off 9 cures under two years, which are well, but which are too recent to be judged as cures, this leaves—

20 reported or seen cured—no truss—at 10 years and over.

11	"	"	"	"	8	"	"
18	"	"	"	"	6	"	"
29	"	"	"	"	4	"	"
15	"	"	"	"	2	"	"

93

Some of the older ones have been good enough to keep me well informed as to their state. Two have gone through a great deal of hard riding in Cape, for many months at a time, and have never been bothered with their old enemy. One, a surgeon in the Cumberland district, rides a great deal and never is troubled. He says he has forgotten that he ever had a hernia."

(ii) *Ball's* (*Brit. Med. Journ.*, December 10, 1887).—Here the sac is twisted, the fundus cut away, and the stump stitched in the ring. I have placed this method next because I consider the method of treating the sac by torsion much simpler than any other, and very efficient. I always treat the sac thus myself, though instead of leaving it in the canal I return it within the internal abdominal ring after Macewen's method, and I also make use of Macewen's method for closing the canal.

Mr. Ball advises that the sac be completely isolated right up to the internal ring, and having been ascertained to be empty, gradually twisted up by a broad catch-forceps grasping its neck, while the left fore-finger frees the upper part of the neck.* In ordinary cases, four to five complete revolutions are sufficient, but this must depend on the thickness of the sac, the torsion being continued till it is felt to be quite tight and likely to rupture. An assistant, now holding the torsion forceps, maintains the twist, while a stout catgut ligature is tied tightly round the twisted neck and cut short. Two sutures of stout aseptic silk are now passed through the skin about $\frac{1}{2}$ inch from the edge of the wound, through the outer pillar of the ring, through the twisted sac in front of the catgut suture, and then through the inner pillar and skin. As the sac now cannot untwist, it is cut off in front of these sutures, which are tied over leaden plates, which lie at right angles to the wound. From investigations on the dead body, Mr. Ball finds that the result of the above procedure is to throw the peritonæum into a number of special folds, radiating from the internal ring in

* Where the hernia is congenital, the sac must be cut through first above the testicle, freed from the cord, and then twisted.

all directions. The ring, instead of being depressed, is rendered more prominent than the neighbouring peritonæum.

I have used this most simple and efficient method very largely, but with some modifications of the author's plan. Thus, before twisting the sac and after freeing it below and from the cord, I endeavour to separate it all around the abdominal aspect of the internal ring. After twisting it up as high and as tightly as possible, I always, if it be thick enough, transfix it instead of merely encircling it with a gut ligature. It is then pushed well within the peritoneal cavity, as I should fear leaving it in the canal lest it act as a wedge and dilate it. Finally, I always supplement torsion of the sac by closing the canal by sutures introduced by Macewen's method.

Torsion is very quickly and simply done; it does away with the need of bringing a thread through the abdominal wall. Another advantage is the crushing together of serous surfaces which tends by plastic effusion to make a plug very efficient in blocking the internal ring, aided by the slight effusion which is set up by the separation of the sac around the abdominal aspect of this aperture.

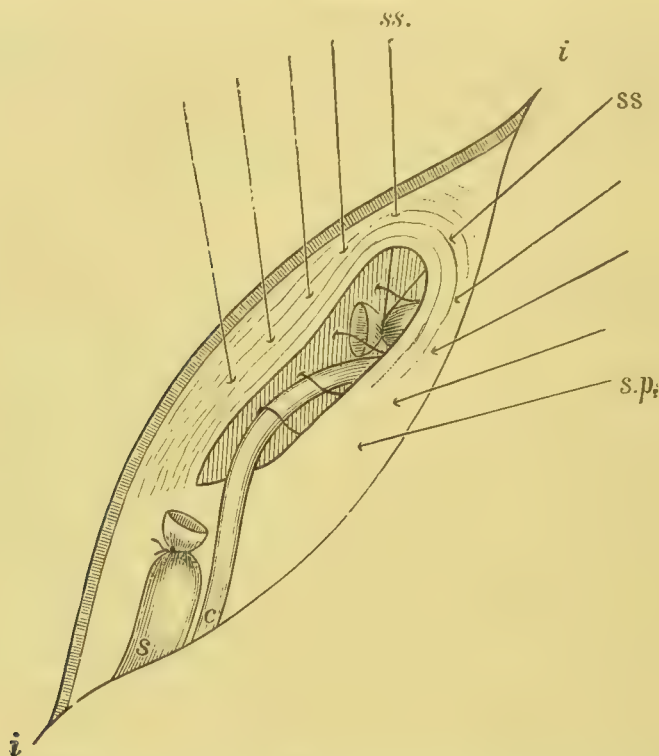
(iii) Method of Banks.* This has the merit of extreme simplicity. The sac having been made certain of, is separated, with the precautions given above (p. 657), from the cord, and detached through the external ring up in the canal as high as the internal ring, the finger keeping note all the time of the position of the cord. If the sac is clearly empty, its neck is now ligatured with stout chromic gut or carbolised silk as high up as to leave no neck, orifice, or dimple at the internal ring. The fundus is then cut away about half an inch below the ligature. As to sutures of the ring and canals, it would appear from his latest paper that Mr. Banks is now satisfied with suturing the external ring. "In inguinal herniæ, in addition to this" (dissecting out and removing the sac as high up as possible) "the pillars of the external ring have been pulled together by two or three silver wire sutures, which are left in position after their ends have been cut very short. They thus constitute three small silver rings, which never appear again, and are less irritating than any other form of suture. I do not put them in with any object of securing a permanent closure of the external ring, but simply to make sure that the hernia shall not descend for a considerable period, so that the inguinal canal (if it be in fairly normal case) may have a chance of contracting. Unless some extensive 'rawing' of the walls of the canal is done, I believe all stitching of it to be of just as much use in securing permanent union as stitching the edges of a cleft palate would be without freely refreshing them. I do not believe it possible satis-

* Papers by the above surgeon, one of our earliest and foremost workers at the subject, will be found in the *Med. Times and Gaz.*, 1884; *Brit. Med. Journ.*, Dec. 10, 1887, and Nov. 11, 1893.

factorily to accomplish a 'rawing' of the inguinal canal, while in a very large proportion of severe cases there is no inguinal canal at all; nothing but a big hole into which three or four fingers can be crammed, whose edges are as thin as cardboard, and from which all anatomical relations have disappeared. My reason for adhering to the operation which I have hitherto used is that it is the simplest of any that has yet been devised."

While all will agree as to the simplicity of the above method, there is an increasing belief that ligature of the sac alone is not to be trusted, partly because a sac thus treated is not strong enough to resist future strains, partly because, as pointed out above

FIG. 159.



Barker's method. *i.i.* Skin incision. *c.* Spermatic cord. *s.* Lower part of sac left *in situ*. *ss.* Sutures to invaginate the upper part of the sac. *s.p.* Sutures for drawing the walls of the canal together.

by Prof. Macewen, it is extremely difficult, if not impossible, to tie the sac so high up that no dimple is left on the peritoneal aspect of the internal ring.

To take another very important point:—Mr. Banks seems to have given up attempting to draw the canal together with sutures. because these will not ensure *adhesion* of the walls. But surely there is a fallacy in his comparison. What we want here is not the adhesion of the two walls of the canal as in the halves of the soft palate, but a permanent narrowing of the canal again so that it may be once more a mere chink or valve instead of a short wide tunnel, or, as in severer cases, a gaping ring. Even if it were

possible, *adhesion* of the walls of the canal would be undesirable for the sake of the cord.

With regard to suturing the external ring alone, this is, I fear, from cases I have seen, quite inadequate. Some attempt should always be made to narrow the internal ring and canal, as by the method of Macewen. Finally, most surgeons have been less fortunate than Mr. Banks in their experience of silver wire. It is very readily sterilised, most easily used, but often fails to become encysted.

(iv) Barker's* Method (Fig. 159). Here the upper part of the sac is drawn up into the abdomen and fixed there, but the lower part is always left *in situ*, as Mr. Barker thinks its removal unnecessary and even mischievous, "as during the dissection the nervous and vascular supply may be seriously damaged." The rings are then sutured.

The neck and upper part of the sac having been separated from adjacent parts, and proved to be empty, two ligatures of strong, fine carbolic silk are carried under the neck and tied about half an inch apart, and the sac divided between them. The upper ligatures are left long. The left forefinger, introduced into the canal and through the internal ring, is made to press its anterior wall forwards. One of the silk threads left long on the upper stump of the sac is now threaded on a needle with a handle, and carried up the canal, inside the internal ring and through the abdominal wall above and external to the external ring, the other is similarly passed through the abdominal wall about half an inch to the inner side of the first. These sutures are then knotted tightly, and by this means the stump of the sac is drawn up into the abdomen and fixed there. The external ring is then closed by sutures which should, if possible, take up the conjoined tendon as well.

(v) Bennett's Method† (Fig. 160). Here also the lower part of

FIG. 160.



Bennett's method. The pillars of the external ring are shown. Some distance above them the two invagination sutures are seen to emerge through the aponeuroses, while, below, they pass through the sac, which has also been tied.

* *Brit. Med. Journ.*, Dec. 1887; *Man. of Oper. Surg.*, p. 334, Fig. 51; *Trans. Med. Chir. Soc.*, vol. lxxiii. p. 273.

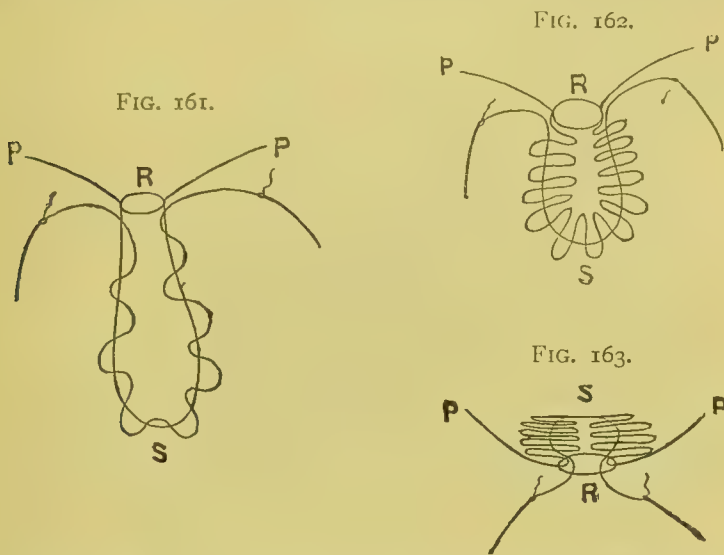
† *Abdominal Hernia*, p. 188.

the sac is left *in situ* for reasons similar to those given above; the upper part of the sac is invaginated through the internal ring, and the canal sutured in the usual way.

The sac is exposed and carefully isolated from its connections just below the external ring (the lower part being left entirely undisturbed); it is then opened, and the contents reduced into the abdomen, if they have not already returned spontaneously.

The sac is now divided just below the external ring, the distal portion being allowed, after all bleeding has been stopped, to drop back into the scrotum. The proximal part of the sac is next separated from the sides of the canal as high up as the internal ring by gentle manipulation. One finger (or more if the ring is large) of the left hand having been introduced into the abdominal cavity through the neck of the sac, any bowel lying near the internal ring is pressed back out of the way. An ordinary pile-needle on a handle (unthreaded) is then made to enter the abdominal aponeuroses about three-quarters of an inch above the upper margin of the external ring, a little to the outer side of its middle line, and transfixes the whole of the aponeuroses and peritonæum, impinging on the end of the finger which occupies the neck of the sac. The needle, guided by the finger, is passed down the inside of the sac and made to pierce its outer wall at a point about half an inch from the cut edge. The needle having been threaded with a tendon or cat-gut suture, previously prepared, and not less than 12 inches long, is withdrawn, taking one end of the suture with it. The result is that one end of the suture is seen passing into the abdominal aponeuroses above the external ring, while the other issues from the outer wall of the proximal part of the sac, near its cut edge. The needle, again unthreaded, is now made to transfix the abdominal aponeuroses and peritonæum about half an inch internal to the point at which it entered before, traversing the sac in the same way, finally piercing the inner wall at about the same distance from the cut edge as it had done on the outer side. After having been threaded with the lower end of the suture, the needle is withdrawn, carrying the suture, as before, with it. The two ends of the suture will now be seen entering the aponeuroses above the external ring, and forming below a loop over the cut edge of the proximal portion of the sac. The open end of the sac is next sewn up by a continuous stitch of catgut or silk, or occluded by a silk ligature placed around it as close as possible to the spot at which the invagination suture pierces its sides. The succeeding step is the invagination of the sac, which is effected by pushing with the finger the closed end through the canal into the abdomen, the invagination sutures passing through the aponeuroses being at the same time drawn tight. By this proceeding the sac is turned completely outside in, and its fundus firmly attached to the peritonæal surface of the anterior abdominal wall some distance above the internal ring."

(vi) Stanmore Bishop's Method (Figs. 161, 162, and 163).^{*} This is a modification of Prof. Macewen's. The sac having been freed entirely up to but not beyond the internal ring, is carefully emptied, and kept so by the finger of an assistant pressing upon the ring. By means of a long, strong catgut suture, which is passed through each side of the sac, this is hemmed round, and thrown into a number of folds. The neck of the sac is then invaginated, and each end of the suture carried by a needle through the canal and through the pillar of the internal ring nearest to it, from within outwards. When both ends are presenting through the muscular structures they are pulled up, the sac being at the same time



Figs. 161, 162 and 163. Method of treating the sac in Bishop's method of radical cure of hernia. S. Sac. R. Internal ring. PP. Parietal peritonæum. In fig. 161 the sac is hemmed round with a silk suture. In Fig. 162 the sac is puckered upon the outer side of the ring. In Fig. 163 the puckered sac is invaginated and forms a button-like projection on the abdominal aspect of the ring. In each figure the suture carries a needle at each end. (Walsham.)

invaginated before the finger as the threads are drawn upon. The sac is then drawn inside-out in its passage, and becomes fixed at a rounded boss exactly over the inner ring, its peritonæal surface being turned towards the intestines, and its first fold on either side being firmly applied to the peritonæum immediately within the ring. The ends of the suture are then tied firmly, but not tightly, over the ring; finally, this and the canal are sutured.

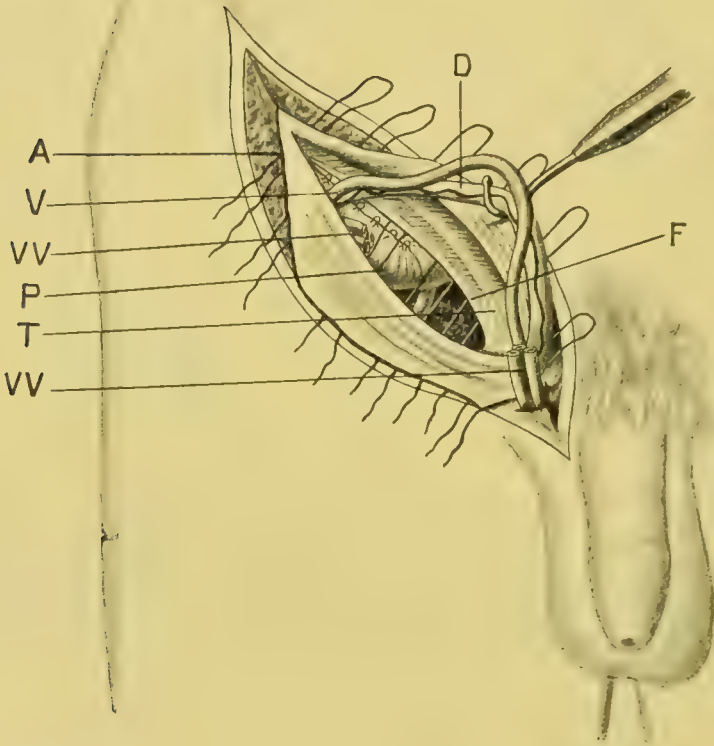
(vii and viii) Methods of Halstead and Bassini.[†] These resemble each other; the points of difference between them will be shown later on. The following is Prof. Halstead's account of his operation (Figs. 164 and 165): "Instead of trying to repair the old canal and

^{*} *Lancet*, vol. i. 1890, p. 1237.

[†] Halstead. *Bulletin of the Johns Hopkins Hospital*, vol. i. No. 1; *Johns Hopkins Hosp. Rep.*, vol. ii.; *Surg. Fasciculus*, No. 1; *Ann. of Surgery*, 1893, vol. i., p. 542.

the internal abdominal ring, I make a new canal and a new ring. The new ring should fit the cord as snugly as possible, and the cord should be as small as possible. The skin incision extends from a point about five cm. above and external to the internal ring to the spine of the pubes. The subcutaneous tissues are divided, so as to expose clearly the aponeurosis of the external

FIG. 164.



Halstead's operation. The inguinal canal laid open; the sac cut away after suture of the peritonæum; elements of cord isolated and lifted up; deep quilt sutures introduced.

A. Aponeurosis of the external oblique. D. Vas deferens. F. Fascia transversalis. P. Remains of sac sutured. T. Conjoined tendon. V. One of the spermatic veins. VV. Stumps of excised spermatic veins.

oblique and the external ring. The aponeurosis of the external oblique, the internal oblique and transversalis and the transversalis fascia are cut through from the internal abdominal ring to a point about 2 cm. above and external to the internal ring. The vas deferens and the blood-vessels of the end are isolated. *All but one or two of the veins of the cord are excised* (Fig. 164). The sac is carefully isolated and opened, and its contents replaced. A

piece of gauze is usually employed to replace and retain the intestines. With the division of the muscles and transversalis fascia, the so-called neck of the sac vanishes. There is no longer a constriction of the sac. The communication between the sac and the abdominal cavity is sometimes large enough to admit one's hand. The sac having been completely isolated and its

FIG. 165.

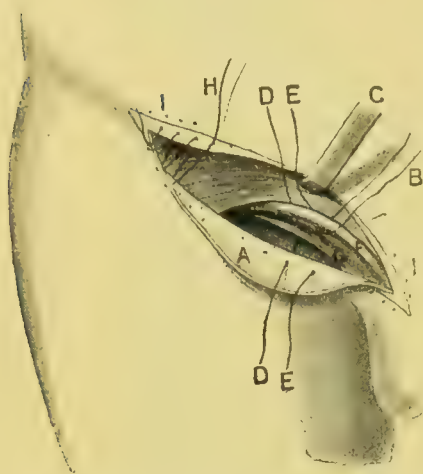


Halstead's operation. The deep quilt sutures which close the canal are tied and cut short. The remains of the cord is seen to emerge between the upper two sutures, and to lie between the external oblique and the skin.

contents replaced, the peritonæal cavity is closed by a few fine silk mattress sutures, sometimes by a continuous suture. The sac is cut away close to the sutures. The cord in its reduced form is raised on a hook out of the wound, to facilitate the introduction of the six or eight quilt sutures, which pass through the aponeurosis of the external oblique, and through the internal oblique and transversalis muscles and transversalis fascia on the one hand, and through the transversalis fascia and Poupart's ligament and fibres of the aponeurosis of the external oblique on the other (Fig. 164).

The two outermost of the deep quilt sutures pass through muscular tissues, and the same tissues on both sides of the wound. They are the most important sutures, for the transplanted cord passes out between them. If placed too close together, the circulation of the cord might be imperilled, and if too far apart the hernia might recur. They should, however, be near enough to each other to grip the cord (Fig. 165). The precise point to which the cord is transplanted depends upon the condition of the muscles at the internal abdominal ring. If in this situation, they are thick and firm, and present broad raw surfaces; the cord may be brought out here. But if the muscles are attenuated at this point, and present their cut edges, the cord is transplanted farther out. The skin wound is brought together by an uninterrupted suture, which is withdrawn after two or three weeks. The transplanted cord lies on the aponeurosis of the external oblique, and is covered by skin only."

FIG. 166.



Method of applying the sutures in Bassini's method of radical cure.

A. Aponeurosis of external oblique turned down. B. Silk ligature holding cord aside. C. Retractor drawing up upper cut edge of external oblique. D and E. Two of the deep sutures passed through the deep internal surface of Poupart's ligament and the conjoined tendon. G. The conjoined tendon. H. Continuous suture for uniting the divided aponeurosis of the external oblique. II. Ends of the skin incision in which some of the points are indicated through which the third row of sutures required in this operation would be passed. (Walsham.)

fascia to Poupart's ligament, thus forming a fresh posterior wall to the inguinal canal. The cord is then placed upon this new layer, and the cut edges of the external oblique are sutured over the cord, a new canal being thus created. The skin wound is then sutured as usual.

Prof. Halstead's and Bassini's operation, though so similar, differ

Method of Bassini.* This, which was published a few months later than Halstead's, runs on much the same lines. The sac having been exposed by a similar incision, is isolated, its neck tied as high up as possible, and the part below cut away. The cord is now raised from the old canal, and held aside, while the edges of the internal oblique, transversalis, and transversalis fascia, which have been first separated from the external oblique and peritonæum, are attached by sutures which pass under the cord to the deeper surface of Poupart's ligament, which has been previously defined. When the above four or five sutures are tied, they sew the conjoined tendon and transversalis

* *Arch. f. Klin. Chir.* 1890.

in the following respects : (1) Bassini always brings the cord out at the internal ring, Halstead at a point as above stated (p. 672), determined by the condition of the muscles ; (2) Bassini does not excise any of the spermatic veins, Halstead believes that it is advisable to reduce the cord as much as possible ; (3) in Bassini's operation the cord lies behind the external oblique, in Halstead's between this and the skin.

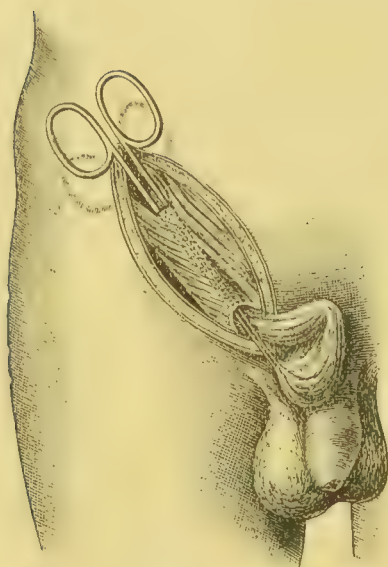
We must wait for further information before we accept such operations as the above as distinctly superior to that of Macewen and others well known in this country. For the present they seem needlessly complicated in the displacement of the cord, the removal of spermatic veins thought to be superfluous (Halstead), and the need of insertion of three rows of sutures (Bassini). Finally, the position of the cord beneath the skin (Halstead) carries, obviously, a possible disadvantage with it.

Long series of cases treated most successfully by these methods have been published. Prof. Halstead (*Ann. of Surg.*, 1893, vol. i. p. 556) has operated 82 times for the radical cure of hernia without a death, and claims that he has no failure to record if recurrences are excluded which could not be ascribed to his method. Of these 82 cases, however, the majority were published at much too short an interval to be called "radical" cures. Bassini had, about the same time, operated 251 times for non-strangulated hernia with but one death, from pneumonia, 15 days after the operation. Bassini claims that out of the above number he only had 7 recurrences ; 108 are stated to have been cured from 1 to 4½ years ; 33 from 6 months to a year ; and 98 from only 1 month to 6 months. In only 4 was the result unknown. I have alluded above to the success of Bassini's method in Dr. Coley's hands, and I have pointed out the insufficient time that here also has elapsed between the dates of operation and publication. On this point I may quote the trite words of some American surgeons (*American Textbook of Surgery*, edited by Prof. W. W. Keen and Prof. J. W. White, Philadelphia, 1892, p. 775) : "As to the curative results of this operation, many operators report wonderfully successful series of cases after six months, a year, or even two or three years, by some special form of operation ; but recent investigations, by impartial observers, of the average number of permanent cures of hernia by direct method of incision, give the proportion of permanent cures as about 50 per cent. Cases may relapse after even five years of apparent cure. Most of our statistics are based on insufficient data, series of cases having been reported within six months to a year after the operation." Coming as these words do from America, they will carry additional weight in the minds of those of my readers who are sufficiently familiar with the surgery of America and the Continent to be aware of the surprising frequency with which cases of non-strangulated hernia are operated on by many surgeons, and published, almost at once, as instances of "radical"—i.e., permanent cure.

ix. Method of Kocher.*—This method is worth noting, as by it it is claimed that the sac is stretched in a direction opposite to the direction of the inguinal canal, and the course of the hernia; and that when the sac is fixed *in situ*, this is done more firmly and in a more permanent manner than by other methods.

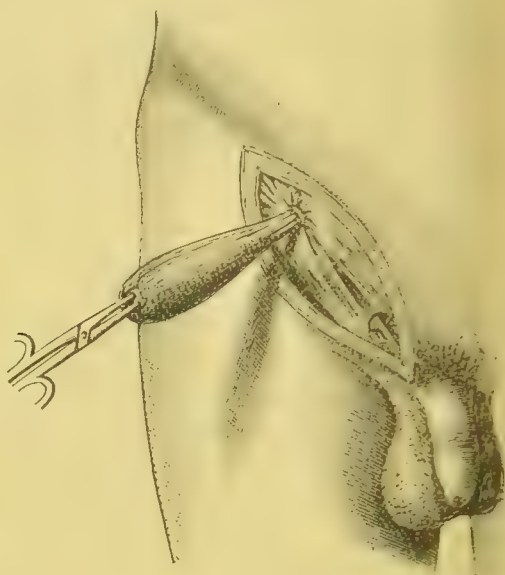
The skin and superficial fascia are divided over the canal. At the external ring the inter-columnar and cremasteric fasciæ are divided, and the sac defined. This is then carefully isolated from adjacent structures, and strongly pulled down so that its pedicle may be exposed. The left index finger is now introduced into the inguinal canal, and to one side of the internal ring a small opening is made through

FIG. 167.



Kocher's operation. The forceps, introduced along the inguinal canal, are grasping the sac at the lower end.

FIG. 168.



Kocher's operation. The sac is drawn out through a small opening in the external oblique aponeurosis.

the aponeurosis of the external oblique; a slender pair of artery forceps is passed through this opening and through the lower muscular fibres of the internal oblique and transversalis, following the left index as it is withdrawn, through the inguinal canal, and finally out of the external inguinal opening. With these the isolated sac is grasped and drawn through the canal, and out at the small opening in the aponeurosis of the external oblique (Fig. 168). It is then drawn out as much as possible, and energetically twisted. It is next strongly drawn down and laid over the outer surface of the external oblique and outer ring, in the direction of the canal. By this tension of the sac the anterior wall of the unopened canal is pressed backwards into a gutter. Deep sutures are now applied, being passed above the twisted sac, through the aponeurosis of the

* *Ann. of Surg.*, 1892, vol. ii. p. 524.

external oblique and the internal oblique and transversalis, through the sac itself, and taking up the Poupart's ligament below (Fig. 169). In the case of a long sac, all that extends below the outer ring is cut away.

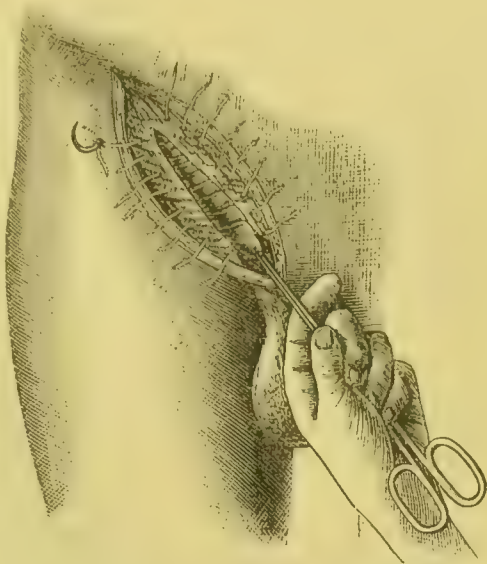
It is claimed that by this method the sac is firmly drawn on the stretch, and securely pressed over the entire length of the canal, so as to form a solid pad or roll. The deep sutures would appear to be passed somewhat in the dark, as regards the cord.

x. **McBurney's Method.** This is different from all others described, in that, instead of trying for primary union, the wound is made to heal by granulation tissue.

The sac having been reached by an incision exposing the whole canal and external ring, is separated and tied as high up as possible. The part below the ligature is then cut away.

In order to keep the wound an open one, the superficial are then stitched to the deep parts; next skin and conjoined tendon above, below skin and Poupart's ligament are sutured together. The wound is then packed with iodoform gauze. The wound is thus made to fill up by granulation tissue, producing a thick scar, which McBurney believes to be the best guard against relapse.

FIG. 169.



Kocher's operation. The sac having been twisted, is laid down upon the aponeurosis of the external oblique. Eight deep sutures are also shown.

RADICAL CURE OF FEMORAL HERNIA.

There is less necessity for operative interference here—women, in whom the above variety is so much more frequent, finding a truss more efficient and less irksome, owing to their less active life and mode of dress. In omental herniæ, where there is difficulty in fitting or unwillingness to wear a truss, in irreducible hernia, and in all cases of strangulated hernia, where the patient's condition and the surroundings of the operator admit of it, an attempt should be made to cure the hernia permanently. We are met here by a difficulty less present in inguinal hernia—*i.e.*, that of closing the canal satisfactorily, owing to the scantiness of some of its immediate surroundings and the importance of others.

Different methods.—

i. The empty sac having been thoroughly separated from its surroundings, a step here usually carried out with ease, is twisted

up tightly, transfixed, and tied with reliable catgut, and then thoroughly invaginated within the femoral ring.

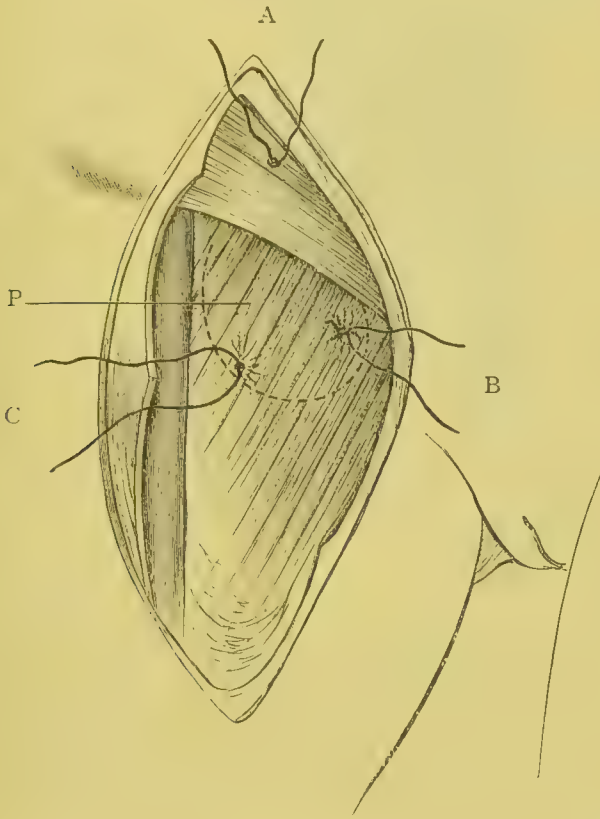
ii. Kocher's method (p. 674) may be employed. The empty sac having been isolated and twisted as strongly as possible, is drawn through a small opening made above Poupart's ligament, and much as described at p. 674, included in sutures which are passed through the pectineal fascia and Poupart's ligament with the hope of closing the femoral canal.

iii. The sac may be treated much as in the methods of Barker and Bennett (pp. 667 and 668). Thus, after it has been isolated and emptied, the neck is thoroughly cleared with the finger passed up the femoral canal. The neck is now ligatured as high up as possible, the body of the sac cut away, and the ends of the ligature, which have been left long around the neck of the sac, are carried up the femoral canal by means of needles on handles along the index finger, and made to emerge in front of the peritoneum through the external oblique aponeurosis just above Poupart's ligament, about half an inch apart. When these are tied the sac will be invaginated; while the above ligatures are passed one assistant should protect the femoral vein, while another draws up the upper angle of the skin incision, so that the needles may emerge in the wound.

The above refers chiefly to treatment of the sac. The other cardinal step in the radical cure of femoral hernia—closure of the femoral canal and ring—is much more difficult here, for reasons above given. Fortunately trusses are much less of an infliction here, and thorough obliteration of the sac on some of the lines I have described will, with the aid of a light-fitting truss, suffice amply. Where it is desired to go further and close the femoral ring and canal, it will be found, owing to the close proximity of the femoral vein, and the fixity of other structures which are adjacent to the femoral and canal ring, that it is impossible to pass a needle with safety so as to take up sufficient tissues to ensure the suture holding. In Mr. Bennett's words (*Clin. Lects. on Hernia*, p. 24) "The effectual treatment of the ring and canal in the radical cure of femoral hernia is a problem which has yet to be solved." Instead of wasting time in putting in sutures which are sure to cut out the surgeon, if not satisfied with invagination and obliteration of the sac, should resort to the following method of Prof. Watson Cheyne. This is criticised by Mr. Bennett as being somewhat severe, and as possessing the inherent defect of dealing with the canal from the wrong end, and thus being powerless to afford any effectual barrier to the entrance of a hernia into the femoral ring itself: "Now there is no doubt whatever, that once a hernia enters the femoral ring, its passage down the whole length of the canal is only a matter of time, and that no amount of plugging or careful obliteration of the *lower part of the canal* will be of more than very temporary benefit in preventing its progress towards complete rupture."

iv. Watson Cheyne's Method (Figs. 170 and 171).—This is shown in the next two figures, taken from Prof. Cheyne's article in the *Lancet*, November 5, 1892: "After the hernia has been reduced the neck of the sac is ligatured and stitched to the abdominal wall (A in Figs. 170 and 171). A flap is then marked out in the pectineus of sufficient size to fill up the crural canal without any tension, and including the whole thickness of the muscle. The incision in the muscle begins at the inner wall of the crural canal, runs for a short distance parallel with Poupart's ligament, and

FIG. 170.

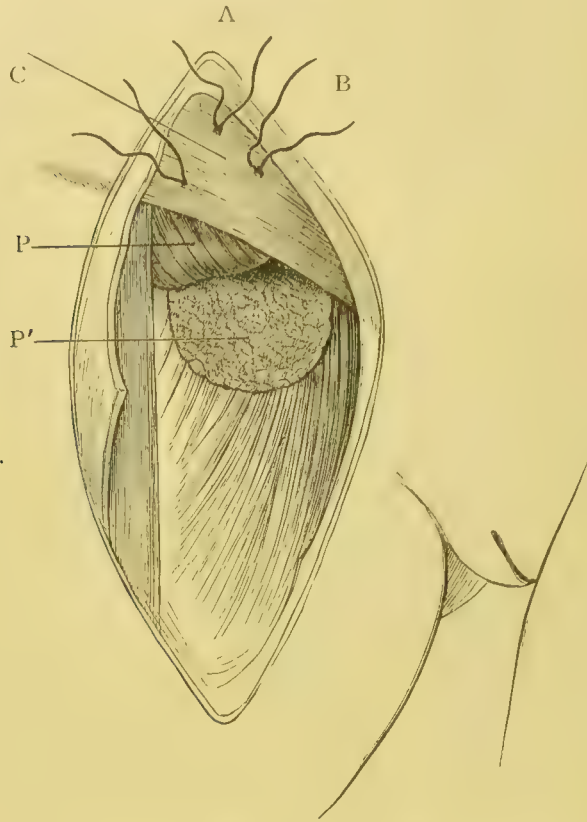


Watson Cheyne's method. A. The suture by which the sac is invaginated and stitched to Poupart's ligament by a needle passed up the crural canal. B and C. Sutures taking hold of a flap marked out in P (Pectineus).

then curves downwards, outwards, and upwards (Fig. 170). At the two lowest angles of the flap stitches are passed and tied, so as to get a good hold of the muscle (B and C, Fig. 170). The flap is then peeled up from the bone and the stitches B and C are passed through the abdominal wall—B above Poupart's ligament, and C just at it (Fig. 171). The result is that the femoral canal is completely filled up with a thick mass of muscle, which soon unites to the sides of the canal; and although its muscular elements may atrophy, a dense mass of fibrous tissue will be left behind." The stitches used were of Chinese silk of medium thickness.

Prof. Cheyne gives two cases in which he operated by this method. The reports are only continued for a few months after the operation, but the results were then very satisfactory.

FIG. 171.



A, B, C. Sutures as before. P. Flap raised from (P') pectineus.

Prof. Cheyne points out that taking up the pectineal fascia alone, as advocated by Salzer of Utrecht (*Centr. f. Chir.*, August 20. 1892) will not prove satisfactory, owing to its being often very thin.

RADICAL CURE OF UMBILICAL HERNIA.

This operation is rarely called for; in children the natural tendency to cure is very marked; and in adults, the kind of patients usually met with—stout women of middle age with damaged viscera, bronchitis &c.—are not suitable for operative interference, save after the operation for strangulation (p. 645).

Treatment by operation may be considered under the following heads:—

i. In congenital hernia of the new-born child.—In these cases, either herniæ into the root of the cord, or (from deficiency of the abdominal walls) partial eventrations, interference is often out of the question from the coexistence of other malformations. If the

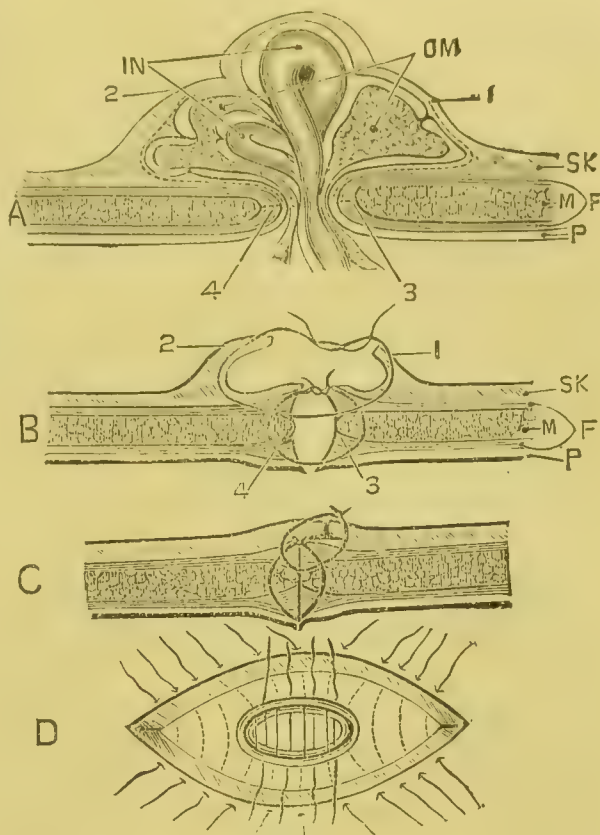
hernia be uncomplicated, and the child appears likely to survive otherwise, an attempt should be made by abdominal section to return the contents, refresh the edges of the opening, and unite them with sutures.

ii. In infantile hernia—the common form in children. In these rare cases, where the wearing of a truss has not been sufficient, an operation may be performed with excellent prospects of success. A simple method is to explore the hernia, reduce the contents, and then, after cutting away superfluous sac and scar tissue, to unite the different layers, peritonæum, fibrous tissues, and skin by separate layers of sutures.

In cases where a pedicle can be made to the sac—not always, from my experience, an easy matter, owing to the directness and shortness of the opening—it may be twisted and invaginated as advised at p. 665, and the other structures sutured over it, or it may be invaginated after the method of Barker (p. 667) or Bennett (p. 668). Another method is that of Mr. Keetley (*Ann. of Surg.*, September 1887). The sac being separated and twisted as in Mr.

Ball's method (p. 664), a stout catgut suture is passed through it, and the peritonæum being very carefully separated from the linea alba above the ring, a needle is passed up into the space thus made, carrying the catgut, threaded, through the sac, and brought out through the linea alba. Then, on pulling the catgut tight, the twisted sac is drawn into the space between the

FIG. 172.



Greig Smith's method of radical cure in umbilical hernia. A. Transverse section through hernia and parietes, showing sac, contents, and ring. IN. Intestine. OM. Omentum. SK. Skin. F. Fascia thickened at margin of ring. M. Rectus. P. Peritonæum. 1. Incision through skin of sac, which is continued along the sub-peritonæal tissue to the margin of the ring. 2. The same on the opposite side. 3 and 4. Incisions carried deeply through thickened fascia around the ring to expose the recti. B. Gut returned, omentum removed, superfluous skin and sac removed, sutures placed, incisions in fascia opened up and recti exposed. References same as in A. C. Sutures tied, skin—suture to one side of parietal line of junction. D. Bird's-eye view showing double set of sutures around umbilical ring and cutaneous wound. (Walsham.)

peritonæum and the linea alba. The edges of the hernial aperture, now freed, are pared and brought together with pins and twisted suture.

For those cases of adult umbilical hernia where the age and the condition of the patient as to her lungs and other viscera is sufficiently favourable, and where a truss or belt are found useless, the operation already recommended in herniotomy for strangulation (p. 645), and the steps for taking away the sac and redundant skin and suturing the ring, will be found sufficient.

Other methods are those of the late Mr. McGill of Leeds, who advocated (*Brit. Med. Journ.*, 1890, vol. i. p. 428) a modification of Macewen's method, *i.e.*—the formation of an internal pad made from part of the sac and fixed in the sub-peritoneal space over the neck of the sac. M. Lucas Championnière in his work on the Radical Cure of Hernia advises that the fibrous edges of the wound be so refreshed and sutured that the edge of one side shall overlap that of the other. The skin incision is united in the ordinary way.

The chief points to bear in mind in the radical cure of umbilical hernia are well shown in the drawing by Mr. Greig Smith (p. 679).

Causes of Death and of Complications which may be met with after Operations for the Radical Cure of Hernia.

1. Sepsis. 2. Peritonitis. 3. Scarlet fever. 4. Tubercular meningitis. This may occur in patients the subject of other apparently quiescent tubercular trouble—*e.g.*, spinal caries. 5. Bronchitis due to the anæsthetic; a danger especially to be avoided in a child who has lately had measles. 6. Pneumonia. 7. Pulmonary embolism. 8. Nephritis. 9. Epididymo-orchitis. 10. Sloughing of epididymis and testicle. 11. Flatulence, with troublesome distension. This condition, so well known after operations on the interior of the abdomen, is known by some as "pseudo-peritonitis."* It is best met by aperients—*e.g.*, calomel gr. v, and Seidlitz powders, given alternately every three hours, until the bowels act; or the following enema may be useful—castor oil ℥ij. turpentine ℥j, soap and water to 8oz. 12. Recurrence. This may be due to the patient's fault—*i.e.*, his not having worn a truss when this was obviously indicated. More often it is due to faulty operating, suppuration, and the resulting thin, stretching scar; or to stitch-abscesses and sinuses, to which I have referred above.

* Where a large quantity of omentum has been tied close by the colon, the action of the above may be inhibited, and the above complication follow to a marked degree.

CHAPTER III.

COLOTOMY.

UNDER this term are included the anterior iliac or inguinal colotomy of Littré, in which the sigmoid colon is opened in the left iliac region; that of opening the ascending or descending colon in the loin, or lumbar colotomy—an operation with which the name of Amussat* is justly associated; finally, the question of making an artificial anus in the cæcum or transverse colon is considered.

The question of the value of colotomy, compared with excision of the rectum in cases of cancer, is dealt with later on.

Before describing and comparing the different modes of performing colotomy I shall deal with those conditions which call for colotomy, then the advantages of the chief methods and the cases to which they are relatively adapted, describing finally the operations themselves.

Indications for Colotomy.—(1) Certain cases of malignant disease of the rectum. I say “certain cases” advisedly, for it is too much the rule to recommend colotomy as soon as rectal cancer is detected, as if no other lines of treatment existed; and it is too much the habit of students, when they see an artificial anus neatly made in these cases, to think that now the patient’s troubles are over. In reality he may be only exchanging one set of troubles for another.

Where obstruction is present, impending, or threatening, where there is extensive ulceration,† great pain, difficult defæcation, loss of sphincter power, profuse blood-stained or fæco-purulent dis-

* Students are often perplexed as to the difference between Amussat’s and Callisen’s operations. Callisen (1796) was the first to suggest such an operation as colotomy, and planned to open the descending colon by a vertical incision. This proposal was condemned by contemporary surgeons. Amussat revived the retro-peritonæal operation, if he was not the first to perform it, but modified it by extending it to the ascending and descending colons alike, and by making use of the transverse incision. Long before Amussat’s time, Littré (1710) had opened the sigmoid flexure through the peritonæum, and in 1776 Pilloré had opened the cæcum.

† As a rule, the first time the surgeon examines a patient, the more the growth tends to become annular, the less limited it is to one aspect of the bowel, or the more it projects into the lumen in tuberos masses, the more likely, *ceteris paribus*, is obstruction to threaten.

charge from the bowel, or multiple fistulæ, the operation is abundantly justified.

In less urgent cases, if the surgeon be doubtful as to recommending this operation, he cannot do wrong if he lay stress on two points, one, that there is always the risk of obstruction setting in, and none can say how soon this may call for colotomy under circumstances much less favourable; the other that there is great hope that the operation by diverting the fæces will arrest the rate at which the growth will otherwise spread.

As a rule, the more complete the failure of previous treatment, the more painful, difficult, frequent, and unsatisfactory the action of the bowels, the greater the tendency to distension of the sigmoid or lower intestines generally, the more frequent the attacks of gripings and partial obstructions, which herald in the torments of a complete *miserere*; the younger the patient, and thus the longer the natural prospect of active life, the more plain are the indications for colotomy. On the one hand, certain special evils* call loudly for the relief which the operation may give—viz., a patulous or invaded sphincter allowing of involuntary escape of flatus and fæces, multiple fistulæ giving rise to foul sanious discharge, keeping the patient (perhaps a woman of scrupulous cleanliness) in a constantly filthy condition, and leading to a brawny, painful condition of the buttocks, which thus readily become the seat of cellulitis and its allies; projection of the growth downwards through the anus, leading not only to a patulous sphincter and its consequent wretchedness, but also to irksome or painful sitting.

On the other hand, certain conditions contra-indicate the operation—viz., exhaustion of strength, evidence of secondary deposits in the peritonæal cavity, liver, lungs, or pleura, extension to the inguinal glands, and absence of much pain or obstruction from first to last.

It has been too much taken for granted that because rectal cancer is often a disease of much suffering, and because, from the inefficiency or neglect of treatment, obstruction does occur, that therefore, when rectal cancer is diagnosed, the patient has, therefore, agonising pain and obstruction to look forward to. The above view is incorrect. In a few cases cancer of the large intestine may run its course, and set up visceral deposits and kill the patient with very little pain, and no threatening of obstruction† whatever; in other cases, and they form a considerable

* To quote only two special wretchednesses—*e.g.*, when a lady cannot rise from her easy-chair without an escape of flatus or fæces taking place from a powerless sphincter, or when a man is threatened with agonies of pain from the carcinoma eating backwards and involving the sacral nerves, and causing caries of the sacrum, with fistulæ and foul discharge.

† In a few cases the growth may, instead of projecting into and obstructing the lumen of the bowel, have led by ulceration to enlargement of the gut into a cavern-like space.

number, and would be still more numerous if efficient treatment were begun early and persevered with, viz., careful attention to diet, regular use of laxatives, daily washing out of the bowel with warm water by a soft catheter or œsophagus tube passed *through* the stricture, followed by the injection of starch and laudanum, or a suppository of cocaine, iodoform, and morphia, will give great comfort for the rest of the day, entirely prevent obstruction, and enable the patient to get about and go to business almost to the last.

Other ever-important points on which the patient or the friends, especially if in a better rank of life, will frequently expect a decided answer, are—the amount of relief, and also the amount of annoyance which will follow on an artificial anus.

The amount of relief given will depend on the amount of pain the patient has, the degree to which obstruction is threatening, or the presence of special miseries, such as those alluded to above. Patients may be assured that any continuous pain will be greatly lessened in severity, if not entirely removed; that defæcation will become easy, painless, and, after the first four or six weeks, limited to one motion a day, save when diarrhœa is present; and that the distress of constant desire to go to stool and tenesmus will disappear.*

The other part of the question—the amount of annoyance following on an artificial anus—must be honestly met. There is too great a tendency amongst writers on colotomy to teach that, if the operation is done sufficiently early, and if its immediate risks are survived, the relief is *always* decided and the patient's condition *always* a most satisfactory one. This tendency has largely arisen from colotomy being so often performed on hospital patients whom it is so difficult to keep long under observation. While it is always right to remember that the disease is a mortal one, and that if a fair comparison is to be made, it must be not between the condition with an artificial anus and that of perfect health, but between an artificial anus and a bowel with incurable cancer, the patient's after-condition will be materially affected by his position in life. Where a patient's remaining days are easy, where he can continue to be careful in his food to avoid diarrhœa, where he can pay regular attention to the opening, this will give little annoyance, and it is also a rule that the greater the miseries of pain, and frequent and difficult defæcation from which the patient has been relieved by colotomy, the more easily does he forget any annoyance of the anus in his relief at what he has escaped from in the past. But, on the other hand, where the surroundings of the patient compel him to try and work, the friction of any prolapsed bowel which follows on movements of the thigh and groin, the difficulty of paying attention to the opening, of avoiding diarrhœa

* *I.e.*, if the opening is free, if there be a good "spur" and no faeces find their way into the bowel below.

from unsuitable food, of washing out the lower bowel—all these may mean that colotomy has only enabled the patient to exchange a life of miseries for one of annoyances, the annoyances of the opening for the miseries of the disease; annoyances certainly less important but not the less present to the patient because they were unexpected. And, as I have said before, the less urgent the conditions for which the colotomy was done, the less the patient has been saved from, the more actively will the annoyances of the artificial opening be present to his mind. The more frequently a surgeon performs this operation, the more will he admit that there are cases, occasional no doubt, in which colotomy, though well performed, fails to give the expected amount of relief.

Putting aside cases where the operation is performed too late, and where the local mischief has been allowed to become too advanced, those where secondary deposits exist, cases where the opening has been too free, or where, with a proper opening, a constant cough, aided by a relaxed condition of tissues, tends to bring about a worrying prolapsus, putting aside cases in which the opening was perhaps originally too small, or in which the patient does not take the trouble to keep the opening dilated as directed, I am of opinion that occasionally causes of failure to give complete relief are met with after an operation quite properly carried out. While I cannot give, and have failed to meet with, an explanation for every case, I think the following are *bonâ fide* causes, and without detracting seriously from the value of this excellent operation, because only occasional, I feel that they have been somewhat unduly overlooked.

Some of these instances of incomplete relief—viz., persistent passage of motions over the malignant disease, and teasing diarrhœa from the artificial and natural anus, have seemed to me to be due: (a) To the lower communication with the bowel being too patent, sometimes no doubt accounted for by the fact that the colon at the spot where it has been drawn into the wound, owing to the shallowness of the loin or the length of the mesocolon, is scarcely kinked or bent at all; this leads to escape of fæces over the malignant growth and much pain and teasing diarrhœa. (b) To persistence of the growth in the bowel below, causing a profuse sanious discharge. (c) To the growth extending upwards towards the wound, or to the bowel having been opened only just above the growth.

(2) Venereal, or syphilitic stricture of rectum, in which previous treatment, including dilatation, has failed, and in which proctotomy* is not available.

* Linear division of a non-malignant stricture posteriorly. If a finger cannot be passed through the stricture, this is first divided with a probe-pointed bistoury to admit the finger. Then a curved, sharp-pointed bistoury, passed through the stricture, is made to transfix the bowel beyond the stricture, and the point is brought out close to the tip of the coccyx. The parts are then cleanly divided by cutting out towards the anus in the middle line. Most strict antiseptic

Much of what has been written above of colotomy for malignant disease of the rectum applies to the operation here also. There is one reason for resorting to it earlier, which may occasionally arise, and that is where the patient is young, and colotomy is called for by extensive ulceration, it is possible that by the rest given by the operation, the above condition may be healed, and the artificial opening closed later on.

(3) Pelvic tumours—*e.g.*, enchondroma or sarcoma—pressing on the rectum.

(4) Results of pelvic cellulitis narrowing the rectum.*

(5) Vesico-intestinal fistula.

Colotomy is performed in cases of communication between the large intestine, especially the rectum, and the bladder, to prevent the passage of faeces into the bladder, with its results of cystitis, agonising obstruction of urine, and passage of flatus from the urethra without notice and beyond control.

Such a fistula is much more frequently met with between the sigmoid or rectum and the bladder; if between the latter and the rectum, the communication may be found by the finger, or by passing a duck-bill speculum and injecting coloured fluids.† Too frequently malignant in character, it is occasionally of a simpler nature—*e.g.*, dysenteric, &c., and so, perhaps, curable. Thus, in Mr. Holmes's case (*Med. Chir. Trans.*, vols. xlix. and l.) the ulceration between the sigmoid and the bladder was not malignant, colotomy for fifteen months was most successful, but a permanent cure was prevented by similar ulceration taking place between the caecum and bladder which caused death. Whether the cause is malignant disease or no, the life which lies before the patient is scarcely tolerable.

The opening is far more frequently valvular in nature—*i.e.*, while it admits of the passage of faeces into the bladder, urine very rarely passes per anum.

6. Colotomy (iliac) is usually performed on the left side in cases

precautions are necessary. In about ten days the use of bougies is commenced.

* This, though rare, is occasionally an undoubted indication for colotomy. I still see from time to time a woman in whom Mr. Howse, over fourteen years ago, performed colotomy for urgent obstruction due to the contraction of the bowel brought about by pelvic cellulitis. More lately I have had under my care a woman, aged twenty-three, a patient of Dr. Howell's, of Wandsworth, in whom chronic obstruction had been brought about by the same cause, dating here to the birth of an illegitimate child. The ring of contraction round the rectum was here so marked, that carelessness in diet or neglect of the use of bougies will, I am certain, lead to colotomy being ultimately called for. The possibility of the mischief in these cases being gummatous must always be remembered.

† The following plan, based upon one made use of by Mr. Lund (*Hunt. Lect.*, 1885, p. 91), would very likely be useful—*viz.*, to pass into the rectum a bougie round which is wound a strip of lint well soaked in starch and water and dried, and then to inject into the bladder some diluted iodine solution. A stain of starch iodide on the bougie would show the position of the fistula.

of malformation of the rectum, when this part of the intestine cannot be found by a dissection in the perineum. It has been disputed in these cases whether, after an unsuccessful exploration in the perineum, an iliac or a lumbar colotomy should be performed. The great majority of surgeons have preferred the former operation, following here Mr. Curling (*Diseases of the Rectum*, p. 228). This surgeon pointed out that the lumbar operation was contra-indicated on the following grounds:—(a) the death-rate is relatively greater; (β) the kidney, varying in size at this time of life, may, when large, overlap the colon; (γ) the colon, instead of being distended with meconium, as might be expected, is sometimes contracted and very hard to find; (δ) in addition to the irregularities in the position of the colon which have already been mentioned, a meso-colon is frequently present.*

Mr. Marrant Baker,† as far as I know, is the only surgeon who has of late years advocated the lumbar operation in cases of imperforate rectum. His reasons appear to be that he thinks that Amussat's operation gives these cases "a good chance of an unwounded peritonæum," and that those who think Littré's operation the better one do so on insufficient grounds. It is noteworthy that Mr. Baker's case, though most successful and alive when last heard of, nearly three years after the operation, was not sent to him till the nineteenth day after birth, when "the abdomen was enormously distended, and the vomiting frequent, and the child much exhausted." No doubt if we could always thus defer operating in these cases, lumbar colotomy would be rendered much safer, but the peril of the children would be much increased. But from my experience at Guy's, and the Children's Hospital with which I am connected, the surgeon is called upon to interfere long before this.

The question was raised by M. Huguier‡ whether, when the inguinal operation was going to be performed, the right loin should not be chosen, as he considered that on this side the surgeon was more certain to reach some part of the large intestine. M. Giraldès,§ on the other hand, has shown that all the inquiries undertaken to elucidate this subject tend to show clearly that the surgeon may rely on finding the sigmoid in the left groin. "Numerous anatomical investigations, together with the records of those of Curling and Bourcart, have shown

* Mr. Curling (*loc. supra cit.*) gives the results of twenty dissections on the bodies of infants, both operations having been first performed. In eighteen out of the twenty, Littré's operation was found easy, whether the bowel was distended or no. In two, this operation failed, as the colon crossed the spine to run down, on the right side, into the pelvis. In eight out of the twenty subjects, lumbar colotomy was easily performed, without opening the peritonæum. In six, the operation was "more or less difficult," and, as Mr. Curling remarks, the difficulties would have been increased in the living. In six, lumbar colotomy was impossible owing to the distinctness and looseness of the meso-colon.

† *Clin. Soc. Trans.*, vol. xii. p. 240.

‡ *Bull. de l'Acad. de Méd.*, tom. xxiv. p. 445.

§ *Lect. Cliniq.*, p. 121. Quoted by Mr. Holmes (*Dis. of Children*, p. 179).

me that in the great majority of cases in the fœtus and newly born child the sigmoid flexure is placed on the left, and not on the right. In 134 autopsies below the age of a fortnight I found the sigmoid flexure on the left side in 114; in 50 cases of Littré's operation which I have collected the operator always met with the sigmoid flexure on the left side; in 30 post-mortem examinations of infants operated on for imperforation the intestine was always found on the left; in 100 examinations of new-born children Curling found the sigmoid flexure on the left side 85 times; and Bourcart, who made prolonged researches in order to elucidate this question, found the sigmoid flexure in its normal position 117 times out of 150."

(7) Dysenteric ulceration and stricture. The treatment of dysentery leading to stricture is rare: when it occurs, ulceration may extend so high up the large intestine as to make even a right-sided colotomy of doubtful value. A case of colitis (the nature of this is not explained), with ulceration, treated by inguinal colotomy and local treatment of the ulcerated surfaces, with subsequent closure of the artificial anus, is recorded by Mr. Mayo Robson (*Clin. Soc. Trans.*, vol. xxvi. p. 213). In patients who give a history of long-standing dysentery and stricture, dysentery is often the result and not the cause of the stricture.

(8) Annular stricture of the sigmoid colon.

(9) Malignant disease of the large intestine higher up—viz., in the splenic or hepatic flexures.

As a much rarer indication for colotomy this deserves mention, viz.:

(10) Cancer of the tail of the pancreas obstructing the splenic flexure. Mr. Beck records a case of this kind (*Lancet*, vol. ii. 1887, p. 113).

When the descending colon was opened neither gas nor fæces escaped, although the abdominal tension caused the gut to protrude through the wound. The finger inserted into the colon could not reach the seat of obstruction. The ascending colon was accordingly opened, and a large quantity of gas and liquid fæces at once escaped. The operation gave great relief, but death took place suddenly (unexplained by the autopsy) seventeen days later.

Of the above ten conditions, the first five will usually be treated by inguinal colotomy, this operation being preferred for the reasons mentioned below (p. 699), as long as the abdomen is undistended. The operation chosen in the seventh must depend on the height to which the disease has extended. In the eighth the surgeon would be justified by cutting down upon the sigmoid colon, with the intention of excising the disease if possible, or opening the bowel above it, lumbar colotomy being only resorted to if neither of the above courses is found feasible. In the last two it will be needful to open the colon high up. It will be well to discuss here the difficulties which often arise in deciding as to

The Site of the Proposed Colotomy.—In the above cases, especially where intestinal obstruction is threatening from malignant disease with distension and tympanitis, the surgeon, particularly if the history is deficient or misleading, may be in doubt as to the site of the disease, and therefore where to operate. It is

quite impossible to make fixed rules for advice, but the following points will help in doubtful cases. Before specifying them I would call attention to two points, one, that malignant disease quite low down—*e.g.*, in the sigmoid—may, by a sudden onset of obstruction, simulate an acuter condition of things higher up, the patient being too ill, or otherwise unable to give an account of previous threatening and finally culminating obstructions. Here the following alternatives lie before the surgeon: (1) to explore the site of obstruction through the linea alba; (2) to cut down upon the sigmoid flexure in the hope that the obstruction may be in this neighbourhood, a very common place; (3) to perform right lumbar colotomy, so as to make sure of relieving any obstruction further back—*e.g.*, in the splenic or hepatic flexures. I would here warn my junior readers on two or three points. If they decide to first explore by abdominal section and find a growth in the colon, descending or ascending, they should not, even if the meso-colon admits of it, bring the bowel into the middle line and open it. Making an artificial anus in the colon by a median incision is usually a matter of difficulty, the bowel not coming sufficiently up into the wound; thus the skin has to be forced down to it, causing tension on the sutures, giving way of these a little later, and either disastrous results or a most unsatisfactory opening. Even if it were usually easy to carry out the above course, I do not consider it would be good surgery, as such displacement of the large intestine may lead to acute obstruction of some loop of the small intestine later on.

I also advise against opening the cæcum if this can be avoided. Owing to the more liquid nature of the fæces here, from the close proximity of the small intestine, though the patient's nutrition will not suffer, the skin in the neighbourhood of the artificial anus is liable to most troublesome excoriations and ulceration.

In cases where the surgeon is in doubt as to the exact site of the disease, but suspects, from the age of his patient, duration of the trouble, history of "indigestion" with unsatisfactory action of the bowels, number of attacks of threatening obstruction, &c., that the mischief is somewhere in the large intestine, attention to some of the following points may be useful:

(1) The proportionate *frequency of stricture in different parts of the large intestine*. The frequency of disease in the rectum and sigmoid flexure, as compared with any other part of the large intestine, and, generally speaking, the frequency of disease in the left side of the arch formed by the large intestine, as compared with such disease in the right side, are well known.*

(2) *The Use of Large Injections*.—Dr. Fagge (*loc. supra cit.*).

* Dr. Fagge, in drawing attention to this fact (*Guy's Hosp. Reports*, 1868, p. 314), quoted the following statistics from Dr. Brinton:—"Of 100 cases, 4 are in the cæcum, 10 in the ascending colon, 11 in the transverse colon, 14 in the descending colon, 30 in the sigmoid flexure, and 30 in the rectum." The statistics of Dr. Fagge and M. Duchaussoy confirm the above.

p. 318) thus writes on this subject: "Several writers, and especially the late Dr. Brinton, have laid stress on the value of large injections as an aid to diagnosis. The observer I have named has even laid down definite rules for our guidance in this respect. 'It is quite singular,' he says, 'how trustworthy I have found the conclusions thus arrived at. For example, with a maximum injection of a pint of warm, bland liquid, the obstruction in an ordinary male adult may be referred to a point not lower than the upper third of the rectum. A pint and a half, two pints, three pints, belong to corresponding segments of the sigmoid flexure. The descending and transverse colon accept a larger, but more irregular quantity. In one case, in which it was evident that the stricture occupied the upper part of the ascending colon, nine pints of injection were always found to be the maximum.'" Dr. Fagge points out that the correct determination of this point requires much care, as (a) some of the fluid measured may escape in the injection; and (b) a stricture may be pervious to fluid injected from below, though the intestinal contents may be unable to pass through it from above. Thus, in a case in which there was a mass of disease in the sigmoid flexure, just above the pelvis, four pints of water were injected per rectum; of this a small portion only returned, the greater part passing through the stricture and adding to the accumulations above it. I would add one more caution with regard to these injections. Patients, in much misery, and having submitted to one or two rectal examinations, will sometimes ask for an anæsthetic. Such an aid must be used with great caution if there is already abdominal distension. There is not only a danger of adding seriously to the distension, and thus further weakening or rupturing parts which may be already near the point at which they give way—*e.g.*, a cæcum with "distension ulcers"—but an anæsthetic, especially chloroform, has additional dangers in such cases as these, where, in a patient probably no longer young, the action of the heart and lungs is interfered with by the upward pressure against the diaphragm. The vomiting, which the anæsthetic may cause, may also prove suddenly fatal, fæcal matter being sucked down into the lungs.

(3) *The distance to which a long bougie or rectal tube passes* is of very little value, and needs only this briefest mention here, because the surgeon is still called to cases in which he is assured that the obstruction cannot be in the rectum or low down in the sigmoid flexure, as a long bougie has been easily passed its full length. This fallacy, which is due to the bougie bending on itself, is more frequent than the other one, in which the arrest of a bougie by one of Houston's folds misleads into the belief that a stricture exists low down.

(4) *The form of the abdomen* may give valuable conclusions. Thus, Dr. Fagge (*loc. supra cit.*, p. 319) gives a case of cancer of the hepatic flexure, in which it was observed during life that the cæcum and ascending colon were distended, and not the descend-

ing colon. Again, he observes that when the rectum or the sigmoid flexure is the seat of obstruction, the lumbar regions and the epigastrium are no doubt generally prominent, and the course of the colon is more or less plainly marked out. That these conclusions are only valuable if not too implicitly relied upon is shown by the fact that cancer of the rectum may be present, with vomiting, peristalsis, and borborygmi, and yet there may be no general distension of the abdomen, no filling out at all of its sides; on the other hand, a prominent epigastrium, and the appearance of a large horizontal coil of intestine here may lead to the conclusion that the transverse colon is distended, the disease being, nevertheless, in the ileum, a distended coil of which has rivalled the colon itself.

(5) A symptom of some value, if verified by the medical man himself, is the fact that for some time the *motions* have been *narrow, tape-like, broken up, abnormal in bulk, shape, and length*. Certain fallacies diminish, however, the value of the above—*e.g.* that in cases of stricture high up, as in the upper part of the sigmoid flexure, there is probably room for the fæces, after they have got through the stricture, to collect, till their characteristic form is given them, though we do not know how far irritation of the intestine and formation of mucus at the seat of the growth may interfere with this.

(6) A few other points—*e.g.*, constant *arrest of borborygmi at one spot, fixed pain at one spot*, as in the right hypochondrium—may give useful indications; while others, such as a *rectal examination* are so obvious as scarcely to need mention.

If, after weighing the above, the surgeon is still in doubt as to the exact site of the disease of the large intestine, he should not hesitate to open the abdomen in the middle line and explore for the site of the disease, or perform a right-sided lumbar colotomy. He should not be deterred from this latter step by the anatomical difficulties (*e.g.*, a more complete peritonæal coat) supposed to exist on this side. Especially where the colon is at all thickened or distended, the operation on one side is no more difficult than on the other.

LUMBAR OR POSTERIOR COLOTOMY.

Though this operation has of late years been very largely replaced by the iliac method, it deserves attention as the operation first largely employed, and as one that has still to be resorted to under circumstances of difficulty. The indications for this operation have been already given at p. 687, and a comparison of the lumbar and iliac methods will be found below at p. 699.

Landmarks (Fig 173).

1. The lower border and tip of the last rib. 2. A point $\frac{1}{2}$ inch behind the centre of the crest of the ilium, this point being found by accurate measurement along the crest between the anterior and posterior superior spines (Allingham). 3. A line drawn vertically

up from the last-mentioned point to the last rib. This gives, with sufficient correctness, the line of the outer edge of the quadratus, and the position of a normal colon. Owing to the varying length of the last rib, the upper end of this line may meet this bone at its tip, or at a spot a varying distance in front of or behind this point. It is well to dot the ends of this vertical line with an aniline pencil. The dint of a finger-nail, made when the patient has been brought under the anæsthetic, will mark these points sufficiently to begin with, but a little later, in a difficult case, the surgeon may be glad of having taken every possible precaution.

Incisions.

1. Vertical, of Callisen. This at first sight is the best, as it follows the above line, and thus corresponds anatomically to the colon, but it has the disadvantage of giving but limited space, especially in a fat or deep-chested patient; and, if prolonged upwards, so as to give all the space possible, it divides the intercostal vessels running with the last dorsal nerve, and gives rise to troublesome hæmorrhage. 2. Transverse, of Amussat. 3. Oblique, of Bryant, modified from the above. One of the two latter is usually employed; they have the great advantage of being readily prolonged when more room is required, and the oblique incision corresponds better with the course of the nerves and vessels.* It is the one given below.

Operation (Figs. 173, 174).

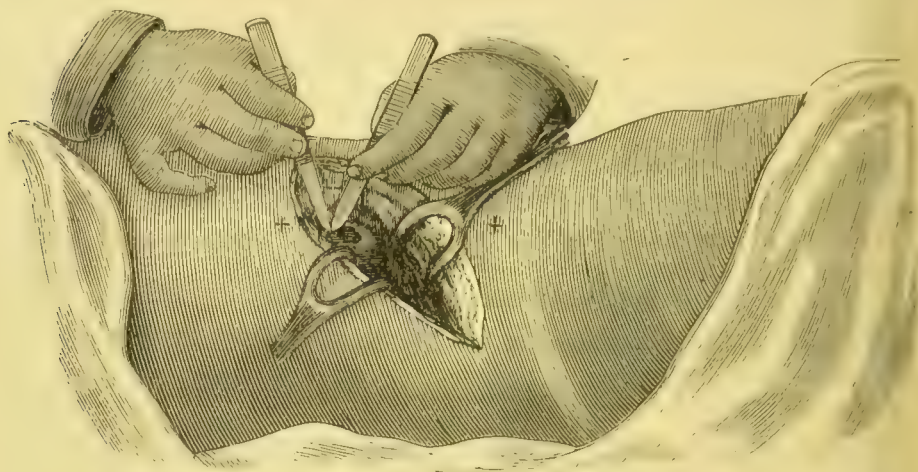
The patient being turned on to his side (most usually the right), with a firm pillow under the loin, the parts cleansed, the tip of the last rib and the point on the crest of the ilium, as given above, being dotted with an aniline pencil, an incision is made, beginning $2\frac{1}{2}$ or 3 inches from the spine, according to the size of the erector spine, a little below the last rib, and running downwards and forwards for $3\frac{1}{2}$ to 4 inches towards the anterior superior spine. The centre of this incision should bisect the line given at p. 173, as the line of the colon.

The first cut should expose the muscles, the skin in the posterior half being thick, and the subcutaneous fat often abundant. The next may go well into the muscles, the remainder of which should then be carefully divided with the knife, or torn through with a steel director, so as to expose the fascia lumborum; any bleeding vessels being now secured, this fascia is pinched up, nicked and slit up on a director. Two retractors being placed on the lips of the wound, the fat which lies around the kidney and behind the fascia lumborum is next torn through and pulled away with the fingers. If the bowel is distended, it will bulge up into

* Mr. Greig Smith (*Abdom. Surg.*, p. 396) gives the following practical hint:—
“In thin patients, and particularly in women, whose iliac crests are more prominent than in men, there is a tendency for the upper lip of the wound to fall inwards, while the lower lip protrudes. This may be obviated by careful apposition, and by not bringing the line of the incision too close to the ilium.”

the wound, pushing before it the transversalis fascia, and the operation can be readily completed. If, on the other hand, the bowel is empty, the real difficulties of the operation only begin at this stage. The wound being well opened, the kidney, if it comes down below the rib (as it occasionally does, especially in a patient breathing heavily under the influence of an anæsthetic), being kept out of the way by the finger of an assistant, the intestine is sought for by scratching with a director, or two pairs of forceps, through the transversalis fascia (Fig. 173) exactly in the line to which attention has been already drawn. Several layers of cellular tissue may be met with here, and it is now that most of the difficulty is

FIG. 173.



The surgeon, having opened the lumbar fascia, is picking his way down through the transversalis fascia to the colon itself. The two crosses mark Allingham's line.

usually met with, owing to the operator being afraid of the peritonæum, and to his not opening the transversalis fascia with sufficient decision. Unless this point is attended to the colon cannot bulge satisfactorily or be drawn up into the wound.

When this has been done, scybala in the colon will in many cases be felt, but if the large intestine is empty much trouble may be met with in detecting it and getting it up into the wound especially if, close by, the peritonæum is bulging up.

At this stage the following points may be usefully remembered

(a) The exact position of the line of the colon (p. 690). (b) The lower end of the kidney, and its relation to the colon. (c) The outer edge of the quadratus lumborum (p. 691). (d) The sensation of thickness as given to the fingers in pinching up the colon thus distinguishing large from small intestine. (e) The feel of scybala if present. (f) Seeing one of the three longitudinal muscular bands which distinguish the colon.* (g) Inflation with air

* Mr. H. Allingham (*Brit. Med. Journ.*, April 28, 1888) seems to consider it very difficult to ensure finding one of these bands without opening the peritonæal cavity. While I should be the last to make light of the difficulties which may

or injection of fluid.* (*h*) Mr. Bryant has advised rolling the patient over on to his back at this stage, so that the colon may be felt to fall on the finger inserted deep into the wound.

The bowel having been found, its posterior surface is to be drawn well up into the wound. This is one of the weak points of the lumbar operation. Owing to the shortness of the meso-colon and the fixity of the bowel, especially when distended, it is very difficult to get the bowel out of the wound sufficiently to get a satisfactory "spur." Unless this is done there is a risk of the patient having a fæcal fistula instead of an artificial anus. If the case is not an urgent one, the bowel, when well pulled up, may be retained there by careful suturing or by passing long hare-lip pins through it. There is no need to pass the pins through the edges of the wound; they simply lie across these, resting on the margins of the wound at either side, a few strips of iodoform gauze being placed under them, or little slips of cork on their ends. The pins should be passed through the bowel at a distance of at least $\frac{3}{4}$ inch from each other, so as to render easy the opening of the bowel in a few days' time, and they should not, if it can be managed, penetrate all the coats of the intestine. The pins are so fine† that any puncture of the canal itself will probably give rise only to a little flatus, readily met with iodoform. The margins of the wound are then carefully closed with silver wire or carbolised silk sutures, and a few fine ones may be passed between the bowel itself and the margins of the wound. The usual aseptic dressings are then applied, iodoform being dusted over the bowel and wound. These dressings will probably not need changing till the fourth day, when the operation is completed by opening the bowel with a tenotomy knife between the pins; this opening may be a small crucial one, very little but flatus will pass at the time, but a director will show the presence of fæces, and mild aperients may be given as soon as the parts are firmly healed. The above

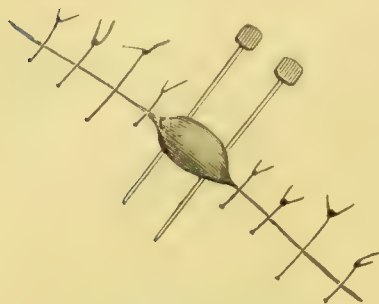
beset this operation, I feel sure that few surgeons, who have had a large experience of colotomy, will agree that the above step is needful, especially if the line given by Mr. Allingham's father be strictly followed. Where the operation is done in two stages the peritonæum may be opened, if needful, without any drawback. But where the bowel must be opened at once, and this will be the rule in lumbar colotomy, any injury to the peritonæum is to be avoided. The aphorism quoted at p. 648 is to be remembered here also.

* Air is most readily made use of. It may be pumped in by a Higgenson's syringe, a Lister's hand-spray, but, best of all, by the special apparatus described by Mr. Lund (*Lancet*, 1883, vol. i. p. 588), which, by means of an elastic ring, secures air-tight contact with the anus while air is being pumped in, either as an aid in colotomy, or as a means of reducing an intussusception. In some cases of cancerous disease of the rectum it will be very difficult to introduce any nozzle for inflation beyond the disease. In the summer of 1885, when performing colotomy at Guy's Hospital in a patient, the lower part of whose rectum had been unsuccessfully excised at another hospital, I found it impossible to introduce any nozzle when desirous of inflating an empty colon.

† A good form of pin is mentioned in the footnote, p. 694.

method of performing colotomy by two stages was introduced at Guy's by some of my senior colleagues, Mr. Bryant, Mr. Howse, and Mr. Davies-Colley, being based on that most important modification of gastrostomy which Mr. Howse was the first to make use

FIG. 174.



Colotomy in two stages. The bowel is shown secured with pins at the close of the first stage. Not enough of the bowel has been pulled up and secured between the pins.

of in this country. Mr. Davies-Colley brought before the Clinical Society (*Trans.*, vol. xviii. 1885, p. 204) a paper on "Three Cases of Colotomy with Delayed Opening of the Intestine." It was from him I learnt the use of the pins† given above. The great advantage of this two-stage method is that it defers the opening of the bowel till this is sufficiently adherent. (2) by this delayed escape of intestinal contents the gravity of any injury to the peritonæum at the time of the operation is very much diminished. (3) The second great trouble after colotomy, that of burrowing suppuration up and down the planes of cellular tissue, which have, of necessity been freely opened, is done away with. The opening of the intestine being delayed, primary union, to a very large extent can be secured, especially with the aid of deeply passed sutures, or of chromic gut ones cut short and dropped in, and dry dressings.

But nowadays, under the conditions in which lumbar colotomy is usually resorted to—viz., obstruction and distended intestine—it will be necessary to complete the operation at one stage. Here the distension, and the difficulties consequent upon it, are best met by tying in a Paul's tube. The wound having been closed as far as is possible, the intestine is dragged out, the surrounding parts are shut off with carbolic lint; a small opening being made in the intestine, the tube is inserted, and tied in, and the patient turned on to his back while the chief of the accumulation in the intestine is allowed to run away safely. When sufficient relief has been given, the bowel may be additionally secured by some sutures between it and the lips of the wound. The wound having been carefully shut off with dressings, the fæces are collected by means of india-rubber tubing fitted on to the tube, soiling of the dressings, &c., being prevented by jackonet.

If a Paul's tube is not at hand, the bowel must be well dragged out, the wound closely adjusted around it, and thickly dusted with

* In six cases of colotomy which I performed in 1887, I used some pins made for me by Messrs. Downs. Their steel is sufficiently tempered to be slightly flexible, thus yielding a little, a point of much importance when the knuckle of colon has to be dragged up to the surface of a very fat loin, and thus exerts much tension on the pins. The flat heads (Fig. 174) rest comfortably on the skin margins of the wound without causing any ulceration.

iodoform, or painted with collodion and iodoform. The patient being then turned on his back and brought over the edge of the table, the wound is carefully shut off with temporary dressings and the bowel opened either by a trocar of calibre sufficient to admit a piece of drainage tube, if the contents are fluid, or by an incision into the gut, which is well pulled out and held over some appropriate receptacle for the escaping fæces. While these are coming away the wound should be carefully irrigated. As soon as the chief distension has been relieved, the opening should be temporarily closed, while the colon, now somewhat collapsed and easier to deal with, is carefully sutured with silk that is not too fine to the edges of the wound, which is again dusted with iodoform or painted over with iodoform and collodion. If the distension be not sufficiently relieved, the means for temporarily closing the colon must be next removed, and the wound, which has been carefully closed and sealed around the dragged out and opened colon, kept as clean as possible by frequent dressing. The parts around must be kept smeared with an ointment of eucalyptus and vaseline, while the dressings themselves are kept in position by a many-tailed bandage, by which means they are readily and painlessly renewed.

The old operation of opening the bowel at once was easy but perilous. A ligature having been passed first through one lip of the wound, then across the bowel and through the opposite lip, and another in the same way about $\frac{1}{2}$ inch from the first, an incision $\frac{3}{4}$ inch long was then made into the gut, over these sutures, their centre hooked up into the wound, and the four halves tied on either side, a few other sutures being put in between the cut bowel and the wound. But in this case there was always some risk of fæcal matter or flatus being forced into the different planes of cellular tissue, especially if the bowel was much distended, even if precautions were taken to keep the knuckle well up, and to close the wound thoroughly around it.

If the bowel is full of scybala no attempt should be made to remove them; they may be left until aperients can be safely given. At times the bowel seems so empty as to suggest a failed operation; there is no occasion to be troubled at this, the contents will pass shortly.

Difficulties in Colotomy.

1. An empty bowel.* This has been already alluded to (p. 692).
2. Mistaking bulging peritonæum for colon and opening it.

* It is noteworthy that the intestine may be found empty, even in obstructions of long continuance. Thus, Mr. Curling (*Diseases of the Rectum*, p. 182) writes: "In a case of carcinomatous stricture of the rectum, in which I performed colotomy, after a month's obstruction, in a woman aged forty, not only was the colon contracted, but it was actually compressed against the spine, and put out of the way by the distended small intestine, so that it was impossible to reach the bowel without opening the peritonæum. No inflammation or unfavourable symptom resulted." It would have been interesting to know whether more than one obstruction did not exist in the large intestine in this case.

This may be due to the surgeon forgetting the line of the bowel and working deeply too far forwards; or it may take place from no fault of the surgeon, being due to the presence of a meso-colon, or to the extremely contracted condition of the colon.* It by no means always causes peritonitis. When this accident has happened, as shown by the escape of a little serous fluid, the appearance of a coil of small intestine or of omentum, the opening should be at once taken up with dissecting-forceps and tied round with carbolized silk or chromic gut, and a little iodoform rubbed round the ligature. If the opening be larger, it must be closed with catgut sutures. 3. A very fat loin. This is not a very uncommon source of difficulty in elderly people who require colotomy. It must be met by a very free incision in which all the tissues are cut equally throughout (*i.e.*, not making a conical wound deep only in its very centre). This not only adds to the difficulty of finding the bowel, but also of retaining it *in situ* afterwards. To meet the additional tension and tendency of the gut to drag away in these cases, it must be more carefully secured by close stitching, especially if it is necessary to do the operation in one stage, every care being taken to prevent extravasation of fæces into the surrounding cellular tissue.† In fat people the surgeon must be prepared, not only for much subcutaneous but for abundant extra-peritonæal fat also, coarse, and difficult to dissect in. If, in such a case, the colon is contracted, there are few more difficult operations. 4. Presence of a meso-colon. This may be a cause of much difficulty and doubt, and render opening of the peritonæum necessary. Where this is the case, the surgeon should always defer opening the colon if possible.

Mr. Jessop (*Brit. Med. Journ.*, 1879, ii. 614) mentions cases in which, owing to the presence of the above, he was obliged to open the peritonæal cavity and incise the gut through its peritonæal coat. The cut edges of the bowel, brought through the opening in the peritonæum, were stitched to the skin as in the ordinary operation. No bad effect followed. Mr. Bennett May (*Brit. Med. Journ.*, 1882, i. 940), operating on the right side, found an empty colon, "and it was only

* In a case in which, owing to the extreme pain during defecation, the patient had dreaded any action of the bowels, and had eaten very little, the colon was much contracted and lay far back. In trying to find it, I opened the peritonæum, and omentum protruded. A carbolized sponge was kept over the opening while the colon was found, the opening then tied up with chromic gut, and the colon not opened for four days. No ill result followed. As in supra-pubic lithotomy the peritonæum may give way during vomiting. Thus, Dr. Walters (*Brit. Med. Journ.*, 1879, vol. i. p. 212) was stitching the colon to the wound when "the patient retched violently, causing the peritonæum to give way and a coil of intestine to protrude from the anterior part of the wound. This was immediately covered with warm sponges, cleansed from the feculent matter it had acquired by contact with the open colon, and returned." When, five weeks later, the patient sank from exhaustion, no trace of peritonitis was found at the autopsy.

† As much of the wound as is possible should be closed before the intestine is opened.

by keeping strictly in Allingham's line, and patiently searching there between the layers of a great length of meso-colon, that the intestine was reached, collapsed and empty."

5. Abnormality of colon. Every surgeon must remember cases in which the descending colon, though present, was displaced, and came down in the middle line. Occasionally part of the large intestine is actually absent.

Mr. Lockwood (*St. Barthol. Hosp. Reports*, xix. 256) mentions three cases in which the colon could not be found; in two its absence was verified at the autopsy, both on the right side. One of these cases is reported fully. The following are the main points:—Owing to obstruction of the large intestine, the site of which was doubtful, it was decided to cut down on the right colon. No colon could be found, and, relief being imperatively demanded, the peritonæum was opened and a loop of small intestine drawn outside the wound. Death occurred four hours after the operation, and at the autopsy the right colon was quite absent,* the cæcum being found behind the liver in the right hypochondrium, the large intestine extending from this to the splenic flexure in the usual manner.

If the colon cannot be found, three courses are open to the surgeon—(a) To open the small intestine through the peritonæum from the colotomy incision. The objections to this step are that it is very fatal, and that there is no telling what part of the small intestine is opened. (β) To perform colotomy on the opposite side, and if the colon is here distended, to open it, in two stages when practicable. This is the course that should always be followed if possible. (γ) If no colon can be found, or if the part found is below the obstruction, the linea alba should be opened to admit two fingers to explore for the displaced colon, and, if no colon can be found, to draw up and attach a loop of small intestine, chosen as near the cæcum as possible. Or Nélaton's operation may be performed, this being the wiser step if the patient is exhausted by a previous prolonged operation. 6. Malignant disease at the site of colotomy. This is best met by performing colectomy in appropriate cases or by performing colotomy on the opposite side. 7. The kidney may be embarrassingly low. 8. The peritonæum may be so pushed back by ascitic fluid that it is impossible to open the gut without injuring the peritonæum (Pepper, *Lancet*, i. 1888, 772). 9. Cases where the operation has to be completed at once, and the colon is much distended with fæces, will give much trouble (p. 694).

Troubles which may be met with after Colotomy.

1. Too large an opening in the bowel. This may lead to prolapse of the mucous membrane. If this take place to a large extent it is a great nuisance to the patient, owing to the moist, excoriated, bleeding surface which results, difficult to keep up by

* Mr. Lockwood (*Brit. Med. Journ.*, 1882, vol. ii. p. 574) explains the abnormalities of the large intestine by the fact that, during its development, it is very mobile, the cæcum occupying first the umbilical, then the left, next the right hypochondrium, and, finally, the right iliac region, abnormalities may follow its arrest at any part of its course.

any apparatus. Even where the opening has been small, a good deal of prolapse may take place if there is much cough, and a flaccid condition of the side.

2. Too small an opening in the bowel. This is of much less moment, as it can be readily dilated by tents. Of these, laminaria are much the most efficient; two should be inserted at a time to effect rapid dilatation. Then the opening is easily kept patent by the occasional insertion of the little finger, and by the wearing of a proper plug. See also p. 708.

3. Teasing descent of scybala into the bowel below the artificial anus. This, which often renders a colotomy disappointing, is best met by bringing the colon sufficiently into the wound at first, and by keeping patent an adequate opening. If scybala still find their way down, the colon may be washed out from the anus or the wound. If these fail, the only course, and one not devoid of risk, is to open up the wound, to divide the bowel, and attach the upper end in the wound, and then to suture the lower end and drop it in. This last step can only be taken with safety if this part of the bowel is empty (p. 707).

Causes of Death after Colotomy.

These will vary somewhat according to the presence of obstruction or no. 1. Exhaustion. Especially if the operation has been deferred too long. 2. Toxic conditions probably due to the continued distension of the intestines, and the resulting absorption by the patient of poisonous material. 3. Extravasation of fæces and burrowing suppuration. This is especially liable to happen in very fat patients, in whom there is a difficulty in getting the colon up into the wound, especially if the bowel must be opened at once. As the fæces pump out under high pressure, a sufficiently * free opening should in these cases be made into the bowel after this has been secured as carefully as possible (p. 694).

4. Peritonitis. This may be due to the operation directly, or more indirectly from fæcal or purulent retro-peritonæal extravasation, or from septicæmia. Often it is not due to the operation, but to the want of it at an earlier stage. Thus, the distended bowel may have given way just above the obstruction; often it is that weak spot the cæcum which is found perforated after the stress of distension.†

* Not needlessly large, for fear of troublesome prolapsus later.

† The following reasons have been given in explanation of this well-known fact—viz., the proneness of the cæcum to give way under the stress of distension and even when at some distance from the obstruction. Dr. Coupland and Mr. Morris (*Brit. Med. Journ.*, 1878) attribute it to the *cul-de-sac* nature of this part of the intestine; its fixity and dependent position; its being the place where two currents meet—viz., from the ileum and, in case of regurgitation, from the colon; and the pressure to which it is subjected between the iliacus and the abdominal muscles. Mr. Lockwood (*St. Barthol. Hosp. Reports*, vol. xix. p. 26) thinks that the explanation lies rather in the peculiarity of structure of the cæcum, as it contains a very large amount of lymphoid tissue, and as its walls are not strengthened equally with other parts of the large intestine by encircling bands.

5. Septic cellulitis, erysipelas, &c. These are not always preventable in an exhausted patient where it has been necessary to open the bowel at once. 6. Vomiting. This has been noticed in a few cases to occur obstinately and fatally after colotomy. Mr. Couper (*Brit. Med. Journ.*, 1869, vol. ii. p. 557) thinks that is not an unfrequent cause of death, and suspects that traction on the bowel, its proximity to the stomach, and the fact that both receive nerves from the solar plexus will account for this. 6. Broncho-pneumonia, pleuritic effusion, especially if the wound has become septic in an exhausted patient.

INGUINAL, ILIAC, OR ANTERIOR COLOTOMY.

Of late years there has been an increasing tendency for this to replace the lumbar operation in the majority of cases which call for colotomy (*vide supra*, p. 687).

The advantages claimed for the iliac operation are chiefly—
 (i) It is easier. Thus (α) the patient, being on his back, takes the anæsthetic better than when rolled on his side; (β) In a stout patient, especially, the soft parts are easier to divide, and the resulting wound less deep, and more readily dealt with than one in the loin; (γ) The bowel is more easily reached, and with less disturbance of deep-lying soft parts; (δ) There is no risk of opening small intestine, or of failing through abnormality of the colon. (ii) The peritonæum being opened of set purpose, the surgeon can examine the site and extent of the disease. (iii) The shallower wound makes it much easier to draw out the intestine, and make a satisfactory angle and spur, or to perform colectomy. (iv) The position of the anus renders it more easily accessible for the needful attention.

If the above advantages are considered separately, I think that there is no doubt that the first, and this is the most important one, is correct. Where the colon is distended, the lumbar operation is an easy one, but where the bowel is flaccid and lies deeply far away in a fat patient, the operation, in spite of the aids given at p. 692, is one of the most difficult in all surgery. I am speaking now from an experience of twenty-one cases of my own, and a large number which I have seen performed by my colleagues. Iliac colotomy with the thinner soft parts, the deliberate opening of the peritonæum, and the more accessible colon, is a far easier and simpler operation. The second advantage claimed, that an iliac colotomy enables the surgeon, by opening the peritonæal cavity, to examine into the site and extent of the disease will be found an important one (as in cases of annular or limited disease of the sigmoid when removal of the growth may be possible, or when the surgeon is uncertain as to the site of the growth, but hopes that an inguinal colotomy may open the disease above it). The third advantage is an important one in those cases where a deep

wound loaded with fat makes it very difficult to bring up and anchor a lumbar colon satisfactorily. On the fourth point, on which much stress has been laid, that an artificial anus in the loin is placed more satisfactorily for the patient's needs than one in the lumbar region, there is something to be said on both sides. A patient with an artificial anus in front can clean this, adjust the pad, and wash out the bowel below far more comfortably. If the motions have been allowed to become constipated, and, in order to get relief, assistance must be given from without—a very real difficulty sometimes, and one requiring considerable time and attention on the patient's part—this can be done very much more easily with an anus in the iliac region. On the other hand, the passage of flatus or the effluvium of a suddenly escaped motion will be greater annoyances with an anus placed in front. And it is obvious that in some conditions of daily life a lumbar opening may be very superior to one in front. Thus at one time I watched for seven years a case of lumbar colotomy which I performed in a young married woman, aged twenty.

The disadvantages of iliac colotomy next require attention.

1. There is the opening of the peritonæum. While I readily allow that antiseptic details, faithfully followed, have gone far to remove the old dread of the peritonæum, there is no doubt that a general adoption of iliac colotomy, with its necessary opening of the peritonæum, in all cases and by all operators, will add to the risk of the operation, especially when the bowel is distended and fæcal extravasation most difficult to guard against. The point is also alluded to, pp. 694, 706. The condition of our patients before colotomy, too often low and poor in repair, and the readiness with which a little peritonitis, ultimately fatal, may be excited must not be forgotten here.

2. A much larger amount of prolapsus follows this than the lumbar operation. Of this there can be no doubt whatever. It must be so, on anatomical grounds, viz., the far greater mobility of the sigmoid colon, the greater laxity of the soft parts in the groin, as compared with those in the loin, where we have the lumbar fascia, psoas, and kidney. These points, together with the fact that in walking, standing, and sitting* the small intestines must necessarily tend to push upon and protrude an inguinal artificial anus, all explain why prolapsus after inguinal is so much more marked than after lumbar colotomy. This result, if the prolapsus be a large one, causes great discomfort to the patient, the projecting, moist, readily bleeding mass in the groin interfering much with cleanliness and locomotion. While the precautions given later will serve to diminish the amount of prolapsus, this will

* "A pad and bandage which is satisfactorily adjusted with the patient standing, will require readjustment with the patient sitting. . . . I have been consulted by several subjects of iliac colotomy on this point, and found their grievance to be a real one" (Bryant, *Lancet*, 1881, vol. ii. p. 1215).

always give more trouble here than in the lumbar region; a tendency to large prolapsus there is quite exceptional, with iliac colotomy it is the rule. On the other hand, it is fair to remember that an artificial anus, as opposed to a fæcal fistula, is much more easily secured after an iliac colotomy.

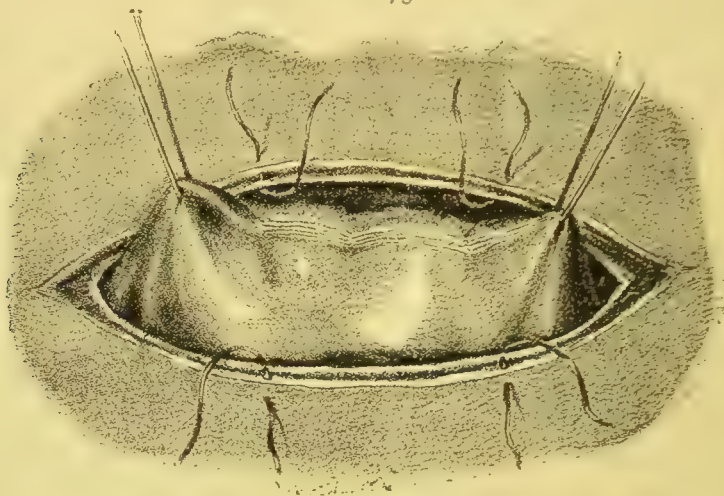
3. Another objection to iliac colotomy, and one which, I thought, would be found a real one, is that for disease high up in the rectum or of the sigmoid flexure, an iliac opening would be placed too near the seat of mischief, does not seem to have been verified. Rectal cancer, for which iliac colotomy is usually performed, very rarely extends high enough up to give any trouble. If, on performing the iliac operation, the surgeon comes down on a growth in the sigmoid, he must resect it, or make an opening above it, or perform a lumbar colotomy.

Operation (Figs. 175 and 176).

The parts being duly cleansed and shaved when needful, an incision 2 or 2½ inches long is made 1½ inch above and parallel with the outer part of Poupart's ligament—the anterior superior spine. There are two points here of the greatest importance from their bearing on the chief drawback of this operation, prolapsus. Mr. Cripps ("Complications arising in Inguinal Colotomy," *Brit. Med. Journ.*, Oct. 19, 1895) finds that by making his opening in the abdominal wall somewhat higher than in his earlier cases, there is much less tendency to protrusion. He now makes his "incision nearly as high as the level of the umbilicus, so that the wall of the lower part of the abdomen, where the pressure is greatest, is left intact." The other point to be insisted on is that wherever the opening is made, it should be as small as possible. The freer the incision, the weaker the abdominal wall—already naturally weak here—and the more certain is a large prolapsus to follow. In an ordinary case of iliac colotomy for rectal cancer, the operator should endeavour to find the sigmoid with an opening admitting one finger to explore deeply, if need be, as far as the pelvic brim, and hook up the sigmoid. In more difficult cases the above small opening should be enlarged at either end with blunt-pointed scissors, cutting on the left index finger as a director. The layers of the abdominal wall (p. 595) having been divided, and all hæmorrhage arrested, the peritonæum is then raised, and slit up with scissors for about two-thirds of the wound already existing. The parietal peritonæum is now stitched to the cut skin on either side by a few points of chromic gut suture. This ensures peritonæal surfaces being in contact when the colon is brought up into the wound. This step has been criticised as unnecessary and as likely to increase the tendency to prolapsus. As the bowel will gradually form adhesions with the margin of the skin wound, the above precaution cannot be said to be absolutely needful; but as it is well, especially in the patients who come to us for colotomy, to assure speedy and firm union, I always make use of it. With regard to this step increasing the tendency to prolapsus, the precautions just

given will obviate this. While the above suturing is going on, a small sponge should be placed in the wound. Either the sigmoid or the omentum or small intestine may be seen in the wound. If either of the two latter present, and the omentum may do so very persistently, they are returned, and the colon sought for with the finger. It is usually close at hand, and may be recognised by the scybala which it contains. In difficult cases the bowel will be found by searching in the iliac fossa, tracing up the rectum, or finding the descending colon over the kidney. It is well to remember that anterior colotomy is not always the easy operation (as regards finding the bowel) that it is represented to be. Mr.

FIG. 175.



(Cripps.)

Cripps speaks (*loc. supra cit.*) of occasionally having had great difficulty in finding the bowel.

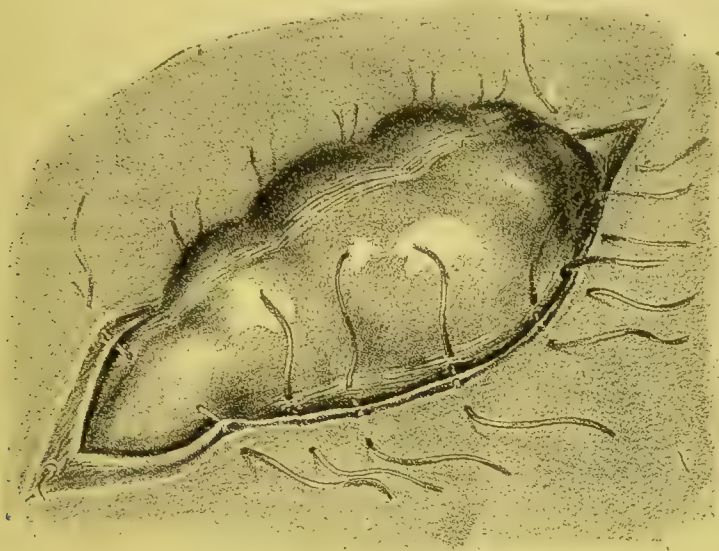
In one case, after a long search, he was unable to find the bowel; the nurse being directed to give an injection of water, the finger near the brim of the pelvis then felt a piece of intestine which had before been overlooked becoming distended, and the sigmoid, which was lying almost over in the right iliac region, was thus detected. In these cases of difficulty Mr. Cripps thinks that the colon will almost invariably be found nearer the middle line of the abdomen than where the operator has been searching.

In a case of Mr. Cooper's, reported by Dr. Pennington, of Chicago (*Journ. Amer. Med. Assoc.*, 1893, vol. ii. p. 773), the operator, having failed to find the sigmoid, water was injected into the rectum, and was noticed to pass into the right iliac fossa. The opening in the left side being closed, an incision was made in the right inguinal region, where the gut, presumably the misplaced sigmoid, was readily found. The patient made a good recovery.

The bowel being found, a loop of it is drawn up into the wound. In the next step the operator should carefully follow Mr. Cripps (*Brit. Med. Journ.*, 1889, vol. i. 771). To avoid the prolapse which is certain to occur if loose folds of the sigmoid remain immediately above the opening, this surgeon gently draws out as much loose bowel as will readily come, passing it in again at the lower angle

as it is drawn out from above. In this way, after an amount varying from one to several inches have been passed through the fingers, no more will come. Two silk sutures are next passed at an interval of 2 inches through the upper longitudinal band—*i.e.*, the one next to the attachment of the mesentery (Fig. 175). These sutures, which are left long, serve to steady the bowel while it is being sutured, and are useful as guides when the bowel is opened.* The colon is now fixed to the skin and parietal peritonæum on either side by fine carbolized silk sutures, six or eight being inserted on either side. Mr. Cripps advises that the sutures for the lower side should pass through the lower longitudinal band,

FIG. 176.†



(Cripps.)

since this is a strong portion of the gut (Fig. 176). The upper longitudinal band, through which the guide-sutures have already been passed, occupies the middle of the wound. The bowel being next drawn down, the upper sutures are inserted close to the attachment of the mesentery. The sutures should be passed with fine curved needles, first about $\frac{1}{8}$ inch from the margin of the skin, and then through the peritonæal and partly through the muscular coat of the bowel, great care being taken not to perforate the mucous coat. After all the sutures have been parted, they are tied up, but not too tightly. Some green protective and iodoform gauze wrung out of carbolic-acid lotion should be then applied over the bowel, and firm pressure maintained.‡ The bowel may

* As stated in the account of colotomy and gastrostomy by two stages, the exposed surface of the viscus is so altered with lymph, &c., that guiding stitches should always be made use of in adults.

† This and the preceding figure I owe to Mr. Harrison Cripps.

‡ This is especially needed during the first few days. Mr. Cripps insists on the nurse sitting by the bedside to apply pressure if vomiting occurs.

be opened between the guide-sutures, on the third or fifth day.* No anæsthetic need be given; if the patient is nervous, a 20 per cent. solution of cocaine may be applied. A few days later all the bowel that projects above the skin is cut away with scissors, Spencer Wells' forceps being applied to each bleeding point.

All sutures should be removed by the tenth day, earlier if any redness is present.

Mr. H. Allingham (*Brit. Med. Journ.*, 1892, vol. i. p. 1013) believes that the above method, while preventing prolapse from the upper end, will not prevent its taking place from the lower when the mesentery is long. He accordingly, instead of pulling out the sigmoid until it is tight at its upper end only, pulls the bowel out until it is tight at the upper and lower ends alike, a step involving the withdrawing and heaping up outside the abdomen many inches of intestine when the mesentery is long. To keep the loop *in situ* a stitch is put through the skin on one side, then through the mesentery behind the bowel, back again through the mesentery, and then tied to the end of the suture which has passed through the skin. When this is tightened, the peritoneum of the mesocolon is kept pressed against the parietal peritoneum, and quickly adheres. The gut is also fixed to the edges of the wound in the ordinary way, and opened about the third day. After about a week Mr. Allingham cuts away all the projecting intestine, sometimes removing as much as a foot, a clamp being first applied close to the skin, while all above the clamp is cut away. The clamp is left on for twenty-four hours. As inguinal colotomy is chiefly performed for rectal cancer, this method, as I wrote in a former edition, appear to me to be needlessly severe. The kind of patient with whom the surgeon is now usually dealing must never be lost sight of. They are too often the subjects of a mortal disease with no very long tenure of life before them, pulled down in strength and feeble in repair. Mr. Treves also condemns the above method very strongly. "There is nothing to recommend this mutilation, and most surgeons will join with Mr. Bryant and others in their condemnation of this uncouth proceeding (*Operative Surgery*, vol. ii. p. 375).

In his later papers Mr. Allingham admitted the severity of this proceeding for cases of cancer, and now reserves it for "cases of simple stricture where patients might live for years."

Mr. Cripps' far simpler and milder method described above, pulling out as much loose sigmoid as will easily come, returning the slack at the lower end of the wound as it is drawn out from the upper, and fixing in the wound a good loop of the part which is found to be tight, will be found amply sufficient. When the projecting loop has been pared down as advised above, two openings will be seen separated by an efficient spur. Through the

* Vomiting, and distension of the abdomen, are other indications for opening the bowel early.

lower of these the rectum can be washed out, and the removal of any fæces lying above the disease facilitated. Gradually, usually in about a month, the patients will begin to acquire some control over their artificial opening, but it will not be till several months after the operation that they can be said to become comfortable in this respect, and acquire satisfactory control over, and management of, their artificial anus. And for the rest of their life discharge of blood and slime will occur from the anus with frequency, varying according to the rate of growth of the original disease. This must be met by astringent injections and suppositories. Diarrhœa must be treated by strict attention to diet, and by astringents: escape of offensive flatus or fæces from the artificial anus, which is more perceptible to the patient after the opening is made in front, may be met by the use of charcoal, a teaspoonful being given twice a day, or the following may be taken twice a day in a capsule or cachet, viz., betol, salol, salicylate of bismuth, of each gr. v (Mr. C. Heath, *Brit. Med. Journ.*, vol. i. 1892, p. 1243).

Where the colon is undistended, and the surgeon can leave the bowel which he has withdrawn as long as he likes, there is a very simple method of keeping the bowel *in situ*, introduced by Mr. Reeves (*Brit. Med. Journ.*, vol. i. 1892, p. 66), which I have used on five occasions, and found very efficient. The sigmoid being pulled out through an opening in the peritoneum, just large enough to allow the loop to rest in it without constriction, as soon as the descending colon is found to be nearly taut, a pair of dressing forceps is pushed through the mesentery about a quarter of an inch from its attachment to the bowel, and a straight piece of catheter No. 10 or 12, or bougie, four inches long and quite clean, or a vulcanite rod is caught in the forceps and drawn through. This is then supported outside the abdominal wall at either end with an aseptic dressing. If the meso-sigmoid is thick and laden with fat, a nick may be made over the forceps and rod, any vessel being, of course, avoided. The bowel should be opened on the third to the fifth day, but the rod should be left *in situ* two or three days longer, as it appears to form a better spur the longer it is left.

I prefer a piece of a solid bougie or a glass rod as more certainly sterilised, and though Mr. Reeves, in three cases he mentions, has found that the bowel, after the withdrawal of the rod, retracts by its own weight and the traction on its mesentery as far as its adhesions allow it, I prefer, as soon as the wound is healing soundly, to snip away the sigmoid to the level of the skin, as advised at p. 704.

Some have objected to this method as unsafe, because liable to allow the escape of small intestine between the edges of the wound and the pulled out loop of sigmoid, as the latter is not sutured. If the wound in the abdominal wall and that in the peritoneum be kept as small as possible, and the sigmoid readily found and withdrawn through an opening which encloses it safely

on all sides, I believe the above accident will not occur. If there has been any difficulty in the operation, and a larger opening has been required, sutures uniting the bowel to the edges of the wound should be employed as well as the rod.

Where obstruction is present, the bowels much distended, and the sigmoid requires immediate opening, anterior colotomy may still be employed, but additional care must be taken in handling the intestines and in preventing any escape of faecal fluid or gas into the peritoneal cavity.

The following methods may be adopted :

Extra pains having been taken to suture the bowel accurately to the edges of the wound, the distended gut is incised, and the faeces as they flood the wound are washed away by a stream of warm water, which is kept constantly pouring over the wound for ten minutes until the distension is relieved. The wound is then most carefully scrutinised and washed, and the dressings applied (Cripps).

Mr. Barker (*Man. of Surg. Oper.*, p. 309) advises that the distended intestine should be opened with a fine trocar. On withdrawing the cannula the puncture is at once closed by mucous membrane. In one case Mr. Barker drew off the fluid through a temporary puncture for several days before a permanent opening was established. The patient made an excellent recovery.

The objection to this method is that where distension is urgent it will be difficult to give sufficient relief by a trocar which is of such small bore that a puncture by it will be safe.

Mr. Mayo Robson has modified this plan on two occasions with success, by puncturing the bowel, already stitched to the side, with a large trocar and cannula, then fixing india-rubber tubing on to the cannula, so that the liquid faeces may be conveyed into an antiseptic solution by the bedside, thus preventing fouling of the peritoneum or wound.

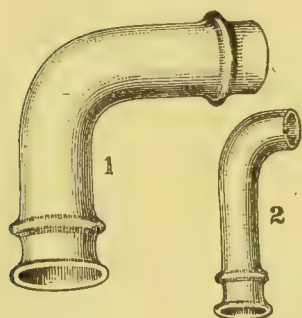


FIG. 177.

No. 1 is for the large, No. 2 for the small, intestine.

The lower end is tied in, the upper receives the drainage-tube. (Paul.)

To save the trouble of fixing the tubing on to the cannula when in the bowel, Mr. Robson has fixed the tubing on the cannula first and then pushed the trocar through it. When the trocar is withdrawn, the slit in the tubing immediately closes, and prevents anything passing through it. This has led Mr. Robson to recommend a trocar with a small lateral limb attached, to allow a tube to be fixed on it to convey the faeces away from the wound. The end of the cannula within the bowel is rounded off so as to avoid a sharp edge; to the other end a short piece of tubing is attached which embraces the trocar, and which is securely closed by a ligature as soon as the trocar is withdrawn. Nothing is said about any difficulty in retaining such a cannula in the bowel; it is merely stated that it may be held in position for the needful two

or three days by strapping applied over an ordinary antiseptic dressing (*Brit. Med. Journ.*, vol. i. 1892, p. 65)

Another method is to tie in a Paul's tube (Fig. 177). See also Enterostomy.

I would strongly impress on my younger readers the need of careful attention to the following points when dealing with chronic obstruction low down in the large intestine by inguinal colotomy. First, the sigmoid is difficult to find, owing to the tendency of the small intestine, much distended, to crowd out of the wound. It is very easy during the necessary handling of such intestine to make small tears in the peritoneal coat. In meeting the above difficulty the operator, if he cannot find the sigmoid quickly, should enlarge the wound and pack away the small intestine with flat sponges attached to forceps. The second point is the great care needed in suturing a distended sigmoid when it is brought to the lips of the wound, it being now very easy to perforate the mucous coat, and thus cause an escape of flatus or fæces before the peritoneal cavity is shut off.

Madelung's Modification of Colotomy.—This has been largely used, both in the lumbar and inguinal operation, abroad. In this country it has not found favour. It consists in drawing out the bowel sufficiently, packing the wound with small sponges attached to silk, while the loop of intestine which, if full, should be emptied as far as possible by squeezing its contents upwards, is packed around with tampons of iodoform gauze. The intestine being clamped or held by the fingers of assistants is next cut across. The clamp is then removed from the lower end, which is emptied, cleansed, and closed by careful suturing, viz., one continuous, and then others by Lembert's method, causing efficient inversion of the sutured extremity. This end is then dropped back into the peritoneal cavity. The upper end is now fixed in the wound or is drained by tying a glass tube in it to which india-rubber is attached, by the method of Mr. Paul (Fig. 177) (*Brit. Med. Journ.*, vol. ii. 1891, p. 118), or that of Mr. Jessett (*Surgical Diseases of the Stomach and Intestines*, p. 306).

The above method has never been much used in this country, for the following reasons:—

1. The great advantage which it claims—of preventing the passage of fæces into the lower part of the bowel, may be secured by much simpler means, viz., pulling out the bowel sufficiently to get an efficient spur, and cutting away the intestine afterwards.

2. It has inherent grave objections:—

(a) It has happened again and again that when the mesentery is long the sigmoid has, unknown to the operator, become twisted, and thus, when it is drawn up into the wound, the upper instead of the lower end may be closed and returned. In such a case faecal extravasation through the sutures into the peritoneal cavity must occur. Mr. H. Allingham states (*Brit. Med. Journ.*, 1891, vol. ii. p. 337) that in seven of his inguinal colotomies the gut must

have been thus "twisted," as fæces came away through the lower of the two openings. He states that he knows of a fatal termination from this cause in several cases in which Madelung's operation has been adopted. Mr. Cripps (*ibid.* p. 447) has met with two cases in which what he believed to be the lower end of the bowel eventually proved to be the upper. Dr. Landon of Göttingen (*Centr. f. Chir.*, Bd. xxx. 1891) has explained the above fact by an autopsy.

In two cases of inguinal colotomy in the Göttingen clinic, where the usual practice is to divide the gut and to stitch the two open ends in the wound, it was noticed that fæces always discharged from the lower and not from the upper opening, although at the operation the lower part of the intestine had been traced towards the bladder and the upper in the reverse direction. In one of these cases, which terminated fatally, the autopsy showed that the sigmoid, which was very long and freely movable, passed upwards and outwards as far as the splenic flexure of the colon, and then curved downwards and towards the middle line, reaching the rectum after a long and tortuous course.

(b) The lower end of the bowel, whatever precautions are taken before the operation, contains some fæces above the site of the cancer: if the lower end of the bowel be sutured, these fæces must cause irritation and increased discharge; if they be scybalous, and the bowel above the stricture thinned, as it often is, they may bring about fatal ulceration. (c) Closing the lower end prevents any attempt at washing out the bowel by syringing through from the colotomy opening to the anus or *vice versâ*, and so diminishing the constant tendency to sanious mucous discharge, which, if left to collect above the cancer, hastens its growth and promotes its sloughing. (d) It adds to the severity of an operation in patients who, from their present and their future, need careful handling. This is true of inguinal colotomies when the bowel is empty. If it be distended, severing the bowel adds greatly to the difficulties of what is now a trying operation, and increases the risks of contamination of the peritonæum.

This modification of Madelung's is, I think, only justifiable when colotomy is performed previously to removal of part of the rectum: even under these circumstances, I think it may be harmful, by preventing the washing out of the intervening bowel, which may add so much to the comfort of the patient. Any surgeon about to divide the bowel should make certain of the lower end by asking an assistant to pass from below, if possible, a small œsophagus bougie.

If the artificial anus contract unduly, it must be dilated with laminaria tents and the patient's finger. Mr. Cripps has introduced a spring dilator which is self-retaining and which can be worn for four or five hours daily. That this complication is one to be watched for is plain from this passage in Mr. Cripps' latest experience (*Brit. Med. Journ.*, vol. ii. 1895, p. 966): "This is not an uncommon sequence, and if allowed will destroy the whole advantage of the operation. Too small an opening means a constant dribbling of fæcal matter, the motions never getting freely and com-

pletely away. These contractions do not occur where the original opening has been made of proper size, and where all the wound has healed by first intention, but occur where the angles of the wound have failed primarily to unite, and where the granulations gradually become converted into firm contractile tissue. If the angles have not united properly, the contraction will begin about the third week, and if at this time a little spring dilator be introduced and worn for a few hours daily for a month, the tendency to undue contraction will be obviated. If this precaution has been neglected or be impracticable, the opening can readily be made the right size by passing the finger into the bowel, and then completely cutting through all the contractile tissue up to each angle, the depth of the cut exposing the wall of the bowel. The bowel is now freed a little on either side of the incision, and a curved needle and silk thread is passed through its edge, and through the tissues and skin at the apex of the reopened wound. This suture is tied, bringing the gut well up to the angle. A couple of additional sutures may be necessary at the sides."

Mr. Cripps considers that nothing in the way of a plug or truss answers so well as a dressing of lint smeared with some simple ointment, covered with a large flat pad of cotton wool, the whole being kept in position by a wide flannel bandage, a perineal strap being used if needful. If a plug is desired, one of the most comfortable is an india-rubber one, which can be introduced collapsed and then inflated by the patient. The chief drawback is that the india-rubber requires frequent renewal in hospital patients.

On the whole, I prefer a pad supported by a light spring-truss, to check any escape of flatus, &c. Its use should be begun early, to give support and check prolapsus.

Complications and Difficulties in Inguinal Colotomy.—Many of those given at p. 695 are common to the inguinal and lumbar operations. Some more specially belonging to the former operation will be given here.

1. Difficulty in finding the bowel. This has been fully entered into at p. 702. It is well to remember that the claim so strongly put forward that the inguinal is an operation of no difficulty, as compared with the lumbar, is not always correct. 2. Absence or shortness of mesentery. I will here quote Mr. Cripps, from his latest experience (*Brit. Med. Journ.*, vol. ii. 1895, p. 966): "This is perhaps the most unfortunate and dangerous complication that can be met with, and to this cause, with one exception, I owe all my fatal cases. In the great majority of cases, the mesentery of the sigmoid flexure is amply sufficient to allow of the bowel being well drawn up in the wound, and safely fixed without tension; but in three or four per cent. this is not so, for there is absolutely no mesentery, the bowel being bound firmly back against the posterior parietes. This is either due to congenital deficiency, or to malignant disease behind the colon, fixing it firmly. The question to be

considered is as to what should be done after the surgeon has opened the abdomen and met with one of these cases. I am confident, from my unfortunate experience, that any endeavour to invert the skin and forcibly drag it down to the bowel by the sutures is a fatal mistake. The sutures will certainly cut through, leaving an open peritoneal cavity. The surgeon has three choices: he may either abandon the operation altogether, he may close the abdominal wound on the left side and perform a colotomy on the right side, or he may endeavour by some modification of the usual operation to fix the bowel without dangerous tension. If he abandons the operation altogether I do not consider he is to be blamed, but most surgeons would prefer to close the wound and open the cæcum or ascending colon. Although the subsequent inconvenience of a right colotomy is far greater than the left, on account of the less solid nature of the fæces, nevertheless it fulfils the chief purpose for which colotomy was undertaken, namely, the establishment of a permanent safety-valve against death from obstruction. If the colon is absolutely fixed and lying at some depth from the parietal peritoneum, this is the course I would advocate. If the bowel is not absolutely fixed, it may be possible by means of a Hagedorn's needle to suture the parietal peritoneum to the sides of the bowel, leaving sufficient space between the two layers for the opening. No attempt whatever must be made to draw the parietal peritoneum and the skin together, the skin and all the structures above the peritoneum being excluded from the sutures. By merely attaching the peritoneum in this way, the tension on the sutures is materially diminished. By opening the bowel opposite to the mesenteric attachment, and then fixing the cut edges to the parietal peritoneum, the tension on the sutures is further diminished. In any case, if the bowel has been fixed with the least tension, the patient must be carefully watched from day to day, and on the least sign of the bowel falling back, additional salmon-gut sutures should be at once passed through the whole thickness of the edges of the bowel and the abdominal walls." I would suggest another means of meeting this difficulty, which I adopted in the only case in which I have met in which the sigmoid was absolutely tied down in the iliac fossa, apparently from a congenital absence of the mesentery. The lower part of the incision being closed, its upper extremity was prolonged backwards into the lumbar region, where, at the junction of the descending and sigmoid colons, the bowel was sufficiently mobile to be brought up into the wound. This course will, I believe, always be found feasible. It is preferable to performing a right colotomy, as it saves two wounds and rolling the patient over on to a recently made wound, while it removes an objection inseparable from a right-sided colotomy, that a more or less extensive tract of bowel is left below the opening, containing fæces, which it is not easy to get rid of. 3. Prolapsus. The frequency of this after the anterior operation has been explained at p. 700. It may

be met (*a*) by making the wound as high up as possible (p. 701); (*b*) drawing down the intestine till the upper end is tight (Cripps). and then bringing it out through as small an opening as possible; (*c*) closing this opening round the bowel, and the bowel to the edges of the wound, as securely as possible, whether a rod (p. 705) has been used or no; (*d*) keeping the patient at rest until the parts have had full time to consolidate; (*e*) treating assiduously any such causes as constipation, coughing, straining in micturition, &c.; (*f*) trying the effect, as early as may be, of a light spring-truss and pad. The two following complications may occur during vomiting or coughing. 4. Small intestine or omentum may escape between the piece of sigmoid which has been drawn out and the edges of the wound. This accident may be known by the urgent vomiting, pain, collapse, and soakage of serum into the dressings. These should of course be removed at once, the small intestine cleansed and returned, and the wound made safe by additional sutures. This accident is most likely to occur when a large wound has been made, an insufficient number of sutures used, and the nurse has not made efficient pressure with her hand over the dressings (p. 703). Where omentum protrudes—a much rarer complication—it may be left, as it will all shrivel away gradually, but additional sutures should be inserted at once. 5. A rarer accident, of which Mr. Cripps has published an instance (*Brit. Med. Journ.*, vol. ii. 1895, p. 967), is where the bowel tears away from its attachments, and falls back into the peritoneal cavity. This happened on the seventh day during a violent fit of coughing.

“The released bowel discharged a considerable motion into the peritonæal cavity. Fortunately, I saw the case about an hour after the accident. The fæcal matter was thoroughly washed out from the abdomen, and the detached bowel restitched. The patient recovered.”*

6. Strangulation of small intestine between the attached sigmoid and the parietes. An instance of this very rare accident will be found recorded by Mr. Cripps (*loc. supra cit.*, p. 967).

A patient on whom inguinal colotomy had been performed was about to leave the hospital when he was seized with symptoms of acute obstruction, the pain being referred to the colotomy opening. After three or four times vomiting the patient said he felt something slip in his inside; the vomiting ceased, and the pain suddenly left him. A few days after, feeling quite well, he was discharged from the hospital, and was re-admitted ten days afterwards in a dying condition. The autopsy showed that a loop of small intestine had slipped down into a canal, about an inch long, between the attached portion of the gut and the reflection of the parietal peritonæum, near the anterior superior spine. From this cause the intestine must have released itself at the first attack. Mr. Cripps adds that prompt abdominal section would have saved this patient.

* Mr. C. Heath's remarks on this or a similar case (*Brit. Med. Journ.*, vol. i. 1892), p. 1243, are worth the attention of any one inclined to think lightly of such an accident because the patient recovered. “Of course we hear of one case that did recover, but we do not hear of the ninety and nine cases which did not.” The remarks which follow on the value of statistics are too bitter for me to insert them here, but they contain a very large germ of truth.

Causes of Death after Anterior Colotomy.—Many of these will be the same as those given in the account of the lumbar operation (p. 698), and others, more peculiar to the anterior operation, have been so fully given in the pages just preceding, that there is no need to repeat them here.

RIGHT INGUINAL COLOTOMY. MAKING AN ARTIFICIAL ANUS IN THE CÆCUM.

This operation is but rarely made use of. One objection to it is that, owing to the proximity of the small intestines, the intestinal contents are likely to be more liquid, and thus to cause more trouble afterwards. It may be resorted to under such conditions as the following:

1. When in chronic obstruction of the large intestine, the site of the mischief is uncertain, and the cæcum is much distended. Here, owing to the tendency of the cæcum to slough from over-distension, a surgeon would be quite justified in cutting down upon the cæcum instead of resorting to right lumbar colotomy, if he felt sure of being able to prevent contamination of the peritoneal cavity from the escaping fæces.

2. When, during the performance of a right lumbar colotomy, finding the colon is impossible.

In the above instances the cæcum would be reached by an incision made over it. And, personally, when the surgeon has been exploring the site of an obstruction through the linea alba and determines to open the cæcum, I think it would be wise to do this through a second incision in the right iliac region, as I consider it risky to anchor intestine in the middle line.

Mr. Treves (*Lancet*, vol. ii. 1887, p. 853) published a very successful case, in which exploration in the middle line detected a stricture at the termination of the descending colon. As the cæcum was enormously distended, its peritoneal coat having given way at several spots, he brought the cæcum into the wound in the linea alba, bringing all the most damaged part out of the wound, which was united around it. A puncture of the cæcum through one of the rents allowed an immense amount of gas to escape. Fortunately no fæces were seen. The hole in the bowel was clamped, and the wound dressed with iodoform. When the bowel was opened on the fifth day a large quantity of fæcal matter escaped. Six months later the patient was in excellent health.

On the other hand, the case of Mr. Cripps, which I quoted at p. 711, shows how very small a space between anchored bowel and the parietes may be sufficient to bring about a fatal strangulation.

Operation.

This differs so slightly from a left-sided iliac colotomy that very little more need be said.

The incision should be about three inches long over the distended intestine, or parallel with the outer part of Poupart's ligament and the iliac crest. There is, usually, no meso-cæcum; but from the few published cases there does not appear to have been any difficulty in getting the cæcum satisfactorily into the wound.

MAKING AN ARTIFICIAL ANUS IN THE TRANSVERSE COLON.

This is the most rarely performed of all the colotomies. Mr. H. Allingham gives three cases in his book on Colotomy, p. 170, one of his own, and two performed at St. George's Hospital.

In one chronic obstruction was present, and a median incision showed a growth in the descending colon. The lower part of the exploring incision having been closed, in the upper two inches the parietal peritoneum was stitched to the skin, the transverse colon was brought out here and stitched in the usual way. The bowel was opened the next day. In another case, opening the transverse colon was preferred to lumbar colotomy, on account of the difficulty of making a satisfactory spur in the latter position.

CHAPTER IV.

OPERATIONS OF THE KIDNEY AND URETER.

NEPHROTOMY—NEPHRO-LITHOTOMY—CALCULUS IN URETER—NEPHRECTOMY—NEPHRORRAPHY.

NEPHROTOMY.

As this operation is performed by the same steps which form the preliminaries of more important operations,* and as the conditions which call for it are dealt with a little later it will not be separately considered here.

NEPHRO-LITHOTOMY.

Indications.—Before a nephro-lithotomy, safe as it usually is, is decided upon, the following points should be considered :

A. That failures to find a stone are by no means infrequent. —Nephro-lithotomy is one of those advances in modern surgery in which the operation has outstripped the diagnosis. What with the pitch of excellence to which our anæsthetics, instruments, and the aseptic precautions, both during and after the operation, have been brought, what with the comparative simplicity and uncomplicated surroundings of the organ which we attack, the operation of nephro-lithotomy has been rapidly perfected, while the diagnosis of stone in the kidney often remains uncertain to the last. Mr. H. Morris, in his address before the Medical Society in 1885, said he knew of fifteen cases more or less typically indicative of renal calculus, in which an exploratory operation failed to find a stone. There is strong reason to believe that while every successful case of nephro-lithotomy is published, a large number of unsuccessful explorations are never heard of. To mention my own experience, while I have on twenty-one occasions removed calculi by nephro-lithotomy, I have six times explored kidneys for stone, both by multiple puncture and incision, without result. These six cases must be alluded to :

(1) A case of lithiasis in a hypochondriac, who greatly exaggerated his symptoms, and having heard of nephro-lithotomy, asked for the operation.

* See the full account of nephro-lithotomy which follows.

Dr. Pye-Smith, whose patient he was originally, and I were very doubtful about the existence of a calculus. After the operation the pain was lost with suspicious rapidity, and the patient remained well when last seen, seven months later. As I did not explore, with a sound, the pelvis and calyces in this case (p. 726), it is possible that I overlooked a small stone, which subsequently became fixed and painless. (2) A case of painful movable kidney, in which the pain was referred to an attack of gonorrhœa, which perhaps set up slight pyelitis. (3) Malignant disease involving the last dorsal nerve, secondary to carcinoma of the bladder. This case shows how closely the presence of renal calculus may be simulated, and how misleading evidence may be. Ten years ago a patient, aged forty-four, came under my care with hæmaturia, wearing pain, tenderness in the right loin and thigh, and oxaluria. His childhood had been passed in Norfolk, and, as a lad, he had been cut by Mr. Birkett for stone in the bladder. I sounded him twice, and finding no stone, I swept the sound in contact with the bladder in different directions, in the hope of detaching fragments of growth, if one were present. No relief being given by drugs, I explored the right kidney, and could find nothing abnormal. Four days after the operation, when all seemed to be doing well, the patient died very suddenly. At the autopsy we found (*a*) a primary carcinomatous growth in the bladder* of a somewhat unusual kind; it involved the apex, as a flocculent, superficially-ulcerated area; (*b*) a ring of secondary deposit surrounding the *right* last dorsal nerve, just at its exit from the spine; (*c*) a mass of enlarged glands around the inferior cava, and at one spot sprouting into it; (*d*) the *left*† kidney contained a large branching calculus. (4) A case of pain and hæmaturia with granular kidney. The patient here, aged sixty-one, had constant hæmaturia and left lumbar pain; as the specific gravity of the urine did not exceed 1012, I contented myself with exploring the kidney with a needle, after it had been exposed. Bronchitis, running into bronchopneumonia, largely due to foggy days, carried off this patient on the fourth day. The kidneys were granular, the left especially so. I should have acted much more wisely if I had watched this patient longer, but the hæmaturia had baffled much painstaking on the part of the medical man who sent him to me, and I attached far too much importance to uric acid crystals in the urine. This case came under my care before the papers of Dr. West and Mr. Bowlby, to which reference is made later, had appeared. (5) This was, I believe, in the light of a larger experience, very early tubercular disease. (6) A case of cystic disease of the kidney (perhaps kidneys) simulating renal calculus with right-sided lumbar pain and hæmaturia. This patient, a gentleman, aged thirty-three, was placed under my care, October 1895, by Dr. Bligh of Caterham Valley and Dr. W. Wilson of Shepherd's Bush. He stated that he enjoyed very good health up to August 1892, when he had typhoid fever. In February 1893 he had pain in the back and what was called "congestion of the kidneys." In August 1893, the lumbar pain continuing, he was treated for "albuminuria." In December 1893, and October 1894, the patient was laid up with acute attacks of right-sided lumbar pain, and the urine was now of "porter colour." There were two attacks in June and October 1895, of a similar character, and at the first of these he came under Dr. Bligh's care. The

* The hæmaturia, frequent micturition, and acid urine led me to discuss the probability of growth in the bladder. The urine was repeatedly examined for cells, and the bladder was sounded under chloroform in the hope of detaching some growth. This was, however, nullified by the position which the primary growth occupied, and by its small size.

† No history of pain had been given here, the patient's attention having been drawn to the *right* side, where so terrible a cause of suffering existed. As bearing on the occasional latency of renal calculus, I would refer my readers to p. 733.

pain was felt in the right loin, and passed down towards the iliac fossa but not into the testicle. There was tenderness in the usual spot, under the last rib. On October 17 I explored the right kidney through the loin. The kidney, not enlarged, was studded throughout by cysts of varying size, none larger than a grape, bluish-green in colour, their walls consisting of a very thin pellicle of apparently wasted cortex; when this was ruptured some yellowish-green fluid came away with a little blood, and left a smooth concave depression in the cortex. Needle-punctures in twelve places failed to detect any calculus, and the same was the case when an incision was made at the lower part of the convex border, and a small sound introduced into the calyces, pelvis, and top of the ureter. This tube when hooked up with the finger and traced down felt quite natural. That the kidney was a poor one was shown by the fact that when it was incised, only yellowish serum came away, there being none of the usual free escape of venous blood. Furthermore, during the week that followed the operation there was none of the usual blood-stained urinous soakage of the dressings. These required changing about twelve hours later, and then not again for three days. Passage of bright, blood-stained urine on two occasions showed that the ureter was pervious. The patient made a good recovery, but it is too early to say if this kidney will shrink up. The fact that the organ was a poor one, the urea only 263 gr. in twenty-four hours, and the frequency with which the condition mentioned above is bilateral, made us decide not to remove it.

B. Symptoms and Conditions justifying Nephro-lithotomy.—

1. *Continued Hæmaturia or Passage of Blood and Pus.*—I may at once be criticised for putting this first; and, indeed, it is somewhat difficult to decide which symptom of renal calculus is clinically the most important.* On the whole, I am inclined to agree with an old friend, G. A. Wright, of Manchester (*Med. Chron.*, March, 1887, p. 463), who considers “renal hæmaturia as the only single symptom of anything like cardinal importance,” if of more than a year’s standing, without evidence of nephritis, and if without a co-existing renal swelling.

A few words as to the character of the hæmaturia of renal calculus and the fallacies which must be borne in mind. It is a hæmaturia of long standing, often repeated, frequently increased by exercise, rarely profuse, and never producing anæmia, as in growth of the kidney. Always intimately mixed with the urine, its tint varies from a bright or a deep red (which I think are rare) to a smoky or porter-like colour.

Fallacies: (a) Hæmaturia may be absent from first to last. This, an undoubted fact, is one very difficult of explanation. It was the case with the smaller calculus (Fig. 178). And this is the more extraordinary, as the stone is covered with minute crystalline spicules, a condition which would have appeared certain to lead to oozing from the inflamed mucous membrane of the pelvis in which the stone lay. The only explanation that I can give is that at the operation I found the abdominal muscles extremely rigid; even when the patient was fully anaesthetised, they gave the impression to the scalpel of cutting through tissues frozen by

* Being convinced of the frequency of errors of diagnosis in renal calculus. I have dealt with these fully. I may also refer my readers to my paper, *Brit. Med. Journ.*, 1890, vol. i. p. 117.

ether. Now, if it is fair to suppose that on the other side of the kidney the quadratus and psoas were as firmly contracted, the kidney and the stone in its pelvis may have been so firmly held that no irritation by the calculus could take place, and thus no hæmaturia. (b) Another fallacy is that the hæmaturia of calculus may be only temporary, present for a while and then ceasing altogether. This occurs, though rarely, when a small renal calculus becomes encysted. (c) The value of hæmaturia, though only occasional, is shown by a case of Dr. Owen Rees, to which Mr. Morris has drawn attention.

It was that of a young lady with lumbar pains and frequent micturition, which were both put down to the hysteria that was markedly present. After a while, hæmaturia was found to be present on several occasions, and eventually, after death, a mulberry calculus was found in one kidney.

Other fallacies are presented by the host of kidney conditions which may give rise to hæmaturia—namely, (1) the passage of uric acid crystals; (2) tubercular kidney; (3) granular kidney; (4) growths; (5) increased intra-renal pressure, &c. To these I shall refer later.

(2) *Pain and Tenderness, Lumbar and elsewhere.*—(a) Fixed lumbar pain. Characters: Usually dull, gnawing, pricking or aching, increased usually by exercise, twisting from side to side, or flexing the body.* Sometimes it is relieved by pressure of the hand, leading to thickening and vascularity of the parts when they are incised at the operation. (b) Radiating pain, for example, in the testis,† region of the small sciatic nerve, calf, foot, or in the intestine simulating colic. It is easy to see how readily the pain of a renal calculus, if limited to distant parts, and if occurring without hæmaturia, may mislead. Another point with regard to the pain of renal calculus is the frequency of nocturnal exacerbations. The explanation of this is doubtful, whether, as Mr. Morris has suggested, from the passage of flatus in the colon, at this time over a stone in the pelvis, or, as I venture to think more probable, as accounting for stone whether in the pelvis or in one of the calyces, to the concentration of the urine, and consequent deposit of crystals, which takes place at night, is unsettled. The fact, however, is undoubted.

In the case of a patient, aged fifty-eight, who had suffered from symptoms of renal calculus for thirty years, and from whose left kidney I removed the huge

* As in going upstairs, probably from the pressure on the kidney by the contracting psoas. But the relation of the pain to movement, and the kind of movement which most induces pain, vary greatly. Thus Mr. Butlin's patient is said to have suffered greatest pain when driving, least when riding. Prolonged walking seems the most frequent cause.

† In a case of Mr. Butlin's (*Clin. Soc. Trans.*, vol. xv. p. 113) the patient sought relief from severe neuralgia of the right testis, which was generally retracted and extremely tender. Later on it was noticed that these neuralgic attacks were associated with some lumbar pain and tenderness. Complete recovery followed after the removal of a small, prickly, calcium-oxalate calculus from the pelvis of the right kidney.

calculus (Fig. 177), the pain at night was often so severe as to drive him from his bed into his garden or the streets of the town in which he lived.

On the other hand pain is, much more rarely, absent.

With regard to *tenderness*, Mr. Jordan Lloyd (*Pract.*, vol. xxxix. p. 178), in a paper to which I shall have again to refer, writes thus: "I attach great importance to the evidence to be obtained by immediate percussion over the suspected organ, a method of investigation which has not received that amount of attention to which it is entitled. It is best practised from the loin, just beneath the space between the tips of the last two ribs, and should be made in a direction upwards, forwards, and slightly inwards. It is best for the patient to stand upright before you. The blow should be sharp and decisive, and of force sufficient to affect a structure situated several inches below the surface. It may also be practised from the front, at a point midway between the umbilicus and ninth rib. When a calculus is present, the patient will complain of sharp, stabbing pain at the moment of percussion. Other conditions doubtless give rise to percussion pain, but not of the characteristic stabbing of calculus."

I have tried the percussion test of Mr. Lloyd in many of the cases which have come under my hands for nephro-lithotomy (table, p. 745) since his paper was published. In three the tenderness was increased, but in one only was there any "characteristic stabbing." In this, where a small and very spiculated oxalate of lime calculus occupied the top of the left ureter, the patient at once said, "You stab me there." This patient, No. 5 in the table, was thin and spare.

3. *Points in the Previous History*.—Space will only allow of my noticing a few of those given above, namely, lithiasis and oxaluria, history of a previous stone, history of previous colic.

The history of long-standing lithiasis and oxaluria is of obvious importance, from the fact that the habitual passage of crystals or gravel and the formation of a calculus lie not far apart. But there is another point which has not, I think, received sufficient attention, and that is, that in patients who have habitually, for many years, passed uric acid and oxalate of lime, there is a most serious risk that the minute anatomy of their kidneys will have become seriously damaged by the constant presence of the above crystals. We should all be agreed as to the damaging effect of multiple calculi on the secreting tissue of the kidney. I would suggest that in the future the results on the kidney of the daily passage of crystals of uric acid and lime oxalate must receive sufficient attention before patients at all advanced in life are submitted to nephro-lithotomy. Furthermore, it is obvious that long-continued lithiasis and oxaluria will very likely have led to the formation of bilateral stones.

Under the heading of Renal Colic, I would point out that the vomiting and nausea which are thought to be characteristic of the agony of a descending calculus may also be caused by a stone

which is distending the renal pelvis, and which has not yet begun to make its way down.

4. *Frequency of Micturition*.—The co-existence of irritability of the bladder with renal calculus is well known, and may be explained either by nerve disturbance, or by the blood and pus, or the over-acid urine which often accompanies stone in the kidney. I had hoped that this symptom might prove to be useful in the diagnosis of the site of the stone.

We all know that it is to the pelvis and hilum that the nerves are most freely distributed, and that it is this part of the kidney which is most closely associated with the bladder. For some time I hoped it might prove that if a patient has renal calculus and no bladder irritability, the absence of this symptom would point to the stone being in one of the calyces and not in the pelvis of the kidney. The importance of this distinction, if it existed, will be recognised by any one who has performed nephro-lithotomy. A question always arises before the operation, namely, Where shall I find the stone, in the kidney itself or in its pelvis? A stone in the pelvis, is, as a rule, easily found and removed. A stone in the tissue of the kidney, even if near the surface, is much more difficult to find, while one embedded in a deeply lying calyx may be overlooked, as in Mr. Morris's well-known case (*Med. Chir. Trans.*, vol. lxxiii.). I fear, however, the above symptom is not reliable. Irritability of the bladder may be absent with a stone in the pelvis of the kidney, and may be present with the calculus in one of the calyces.

Another point with regard to bladder irritability is that it may be of value in making that most difficult diagnosis between a calculus and a tubercular kidney. Thus, if a patient with hæmaturia, lumbar pain, &c., has irritability of the bladder which is not relieved by rest in bed, which continues by night as well as by day, it is probable that this is due not to trouble in the kidney alone, but to coexisting ulceration of the bladder, probably confirmed by examination of the prostate and vesiculæ seminales in the male, and by digital exploration of the bladder in the female.

5. *Absence of any Condition in the rest of the Genito-urinary Tract which will explain the Symptoms* (Morris).—"Various diseases of the prostate—tubercle, abscess, and stone, certainly—may give rise to symptoms which simulate renal calculus.

"It has happened to me twice to explore the kidney for stone, with negative results, and the subsequent course of the case has shown that the symptoms were caused by tubercular disease of the prostate. In another case, subsequently to the exploration of the kidney, I had to open an abscess of the prostate; and in a fourth case, where nothing was found at the exploration of the kidney, a prostatic calculus was discovered after death" (Morris, *Brit. Med. Journ.*, 1889, vol. ii. p. 1082).

6. *Failure of Previous Treatment to give Relief*.—I can only touch on one point here—*i.e.*, the question of the advisability of trying to exert any solvent action on a calculus in the kidney.

Whilst, for myself, I attach the greatest importance to the use of large quantities of water, it is rather because this, by washing out the kidneys, removes collections of crystals, and gets the patient into a better state for operation, than because I believe in its possessing any actively solvent action upon the calculus. I do not forget that Sir W. Roberts has proved by experiments on calculi, both those without the body and those in the bladder, that urine rendered alkaline by fixed alkali has a distinctly solvent action.

Dr. Ralfe has reported (*Path. Soc. Trans.*, vol. xxxiii. p. 206) a case of a patient, aged thirty-seven, who, after suffering from uric acid gravel for some years, had a violent attack of renal colic, with profuse hæmaturia, no calculus or gravel being discharged. Alkaline treatment was at once resorted to, and for a time afforded relief, but the patient could not be persuaded to continue it systematically. He was then ordered to drink copiously of soft water—filtered rain water. Two years later he began to pass grit and scales of calculous matter with his urine; and shortly afterwards, after a severe attack of colic, he passed the shell of what had evidently been a solid calculus.*

But it must be remembered that, as my late colleague Dr. Hilton Fagge pointed out (*Medicine*, vol. ii. pp. 373, 383), such solvent treatment is only worth trying in the case of uric acid calculi. He at the same time showed that the greater relative frequency of lime oxalate calculi over those of uric acid, especially in patients after early adult life, is much more marked than is generally believed.

C. Chief Conditions simulating Renal Calculus.—This point has not received sufficient attention.

1. *Lithiasis*.—I have already alluded to this condition, as one which simulates renal calculus by the hæmaturia which crystals of uric acid may cause. Lumbar and testicular pains are also points which mere lithiasis shares with renal calculus. The diagnosis will not be difficult by watching the result of treatment which only gives relief in the one, but clears up the other. Exercise, again, is a test. A patient with renal calculus, who declines or is unsuited for operative treatment, is often much crippled in carrying out palliative treatment, and made worse by the exercise which is otherwise so essential to him.

2. *Tubercular Kidney*.—Lumbar pain and tenderness, frequent

* Dr. Ralfe (*Diseases of the Kidneys*, p. 523) points out that the solvent action of distilled water is due to several influences. In the first place, by causing a low specific gravity of the urine, it induces disintegration, since Rainey has shown, experimentally, that bodies placed in solutions of different density to those in which they were formed undergo molecular disintegration. Again, chemical analysis has shown that those calculi that undergo spontaneous disintegration are always poor in inorganic constituents, the use of soft water diminishes the supply of these, even if it does not actually act as a solvent on those forming the outer crust of the calculus, and so increases the tendency to disintegration. Lastly, soft water probably diminishes the catarrh of the urinary passages, and by diminishing the swelling of the mucous membrane allows a small stone to pass which was before obstructed.

micturition, hæmaturia, are all common to tubercular kidney and renal calculus. The chief aids in the diagnosis appear to me to be: (a) the pyuria; (b) careful examination of the urine; (c) early pyrexia; (d) early exploration of the kidney.

(a) Pyuria.—This is usually present early in the case with a proportionate amount of albumen, without much hæmaturia, the blood often occurring only as a thin layer over the pus at the bottom of the urine-glass, or as small, thready clots. With all the pus the urine is strongly acid at first, then more feebly so, but often remains slightly acid to the last. (b) Careful examinations of the urine.—The sediment contains caseous matter, and sometimes *débris* of connective tissue can be made out, a point of much importance. Finally, there is the bacillus tuberculosis. While I am well aware of the frequent want of success in demonstrating the presence of the bacillus in urine as in bone, I may add that it was found in six out of the thirteen cases in which I have been asked to explore tubercular kidneys.* (c) Pyrexia.—I do not here speak of the hectic which accompanies the advanced stage, but the pyrexia which may be an important factor in the diagnosis much earlier in the case. Often intermittent at first, and liable to be overlooked in the anorexia, nausea, and debility which accompany it, later on, and too late, it becomes only too evident and confirmed. (d) Early exploration of the kidney.—This matter is referred to later, p. 747.

3. **Hydro-nephrosis.**—It is certain that this condition may simulate renal calculus closely. Mr. Bruce Clarke has published (*Lancet*, ii. 1891, p. 984) two cases of this kind. The first was perhaps an early stage of hydro-nephrosis, and the pain a very prominent feature, dull and aching, with severer attacks; but, as it was found at the operation that “the kidney pelvis was very slightly dilated,” the case is not decisive. The second is more convincing. The kidney here was dilated and a mere shell, no cause being found. There was a definite history of several attacks of renal colic, and Mr. Bruce Clarke thought that these had probably been caused by kinking of the ureter.

4. *Slight Pyelitis, not Tubercular.*—This condition may, by

* I may point out here that bacteriology will help the surgeon in difficult cases. My colleague, Dr. Washbourne, has thus cleared up two obscure cases for me this year. One, a delicate woman of thirty-two, with a tubercular history, was sent to me by Dr. Forty, of Wotton, in Gloucestershire, with obstinate cystitis and irritable bladder. The endoscope and digital exploration showed swollen and hyper-vascular mucous membrane, but detected no ulceration. Wiping over the mucous membrane with a solution of silver nitrate (gr. 40—3j) was followed by very great relief lasting over two months on two occasions. At my request Dr. Washbourne injected some of the pus containing urine (in which no bacilli could be found) under the skin of a guinea-pig. No result apparently followed, but when the animal had been killed, one of the nearest chain of glands was enlarged, and caseating. A few undoubted bacilli tuberculosis were found in it. This and the other case will be found in the *Guy's Hosp. Rep.* 1890.

hæmaturia, pus in the urine, lumbar and testicular pain, simulate renal calculus closely. It may follow a gonorrhœa, perhaps a previous stone, or occur in women after pregnancy; perhaps, as Dr. M. Duncan thinks, from some parametritis extending up the psoas to the peri-renal fat and kidney.

Movable Kidney, especially if associated with neuralgia, pyelitis, or if recurring with some of the reflex causes of nephralgia to be mentioned below.

Aching Kidney.—Under this title Dr. M. Duncan has described a condition, especially common in women, which may simulate renal calculus. Its chief features are a heavy, wearying pain, deep in the side, usually accompanied by tenderness, often great; the pain may run in the course of the great sciatic or anterior crural, and is frequently accompanied by irritability of the bladder, and by pain in the course of the ureter. The disease is liable to be aggravated by exercise. The chief points in the diagnosis of this condition are, Dr. Duncan points out, the absence of blood and pus, the fact that the "aching" often occurs only at the menstrual periods and is always worse then, from the intimate connection between the kidneys and the generative organs, not only developmental but pathological.

Nephralgias due to Disease in Parts adjacent to the Kidney.—Dr. Ralfe (*Brit. Med. Journ.*, 1888, vol. i. p. 183) gives some of these; one, he thinks, is duodenal ulcer.

Thus, a patient had many symptoms of renal colic, and three attacks of paroxysmal pain accompanied by vomiting, great tenderness in the right renal region, urine loaded with uric acid, but no pus or blood. The patient, who was losing flesh, recovered with treatment directed to duodenal ulcer. The same writer gives another interesting instance of intestinal irritation simulating nephralgia by causing severe pain in the right hypochondriac region. The patient was treated for biliary colic, and a few days later, instead of a gall stone, a large round worm was passed, giving relief to the pain.

A case still more interesting is given by Dr. Tirard (*Lancet*, vol. i. 1892, p. 16). Though (as the kidney was only punctured) the presence of a calculus cannot be excluded in this case, it is very possible that the explanation given below may meet other nephralgias. A schoolboy, aged twelve, gave a history of hæmaturia with severe pain, after another boy had jumped suddenly and roughly on his back. There was only this one attack of hæmaturia, but from this time occurred frequent attacks of severe pain, which seemed to return with any sudden jolting movements, a railway journey or a ride in a hansom, often proving sufficient exciting cause. It was also noticed that the pain was worse with constipation or diarrhœa. Although no certainty was felt about the presence of a renal calculus, it was generally thought that the symptoms might be due to this. At the operation no stone could be found, though the pelvis and the substance of the kidney were carefully explored by a needle. A firm cicatrix was, however, discovered, circling the capsule of the kidney and the descending colon, and this was

so tough and so extensive that it was thought expedient not to divide it. The lad recovered, and is now able to keep fairly free from pain so long as he attends closely to the action of the bowels.

Gall Stones retained in the Gall Bladder may be taken for right renal calculus. Dr. Murchison pointed out long ago that they not infrequently coexist. My old friend, G. A. Wright, of Manchester, has recorded (*Lancet*, 1885, vol. i. p. 563) a case in which the right kidney was explored for a calculus believed to be in the uterine.

On exploring this tube a hard spot was felt near the brim of the pelvis, and taken for a stone in the ureter. A calculus the size of a pigeon's egg was removed and found to be a gall-stone. Acute peritonitis carried off the patient, and a stone was found to exist in the pelvis of the right kidney, with its apex in the ureter.

While on this subject of nephralgias due to conditions of viscera near the kidney, I may refer to some remarks of Mr. Godlee (*Pract.*, vol. xxxix. p. 246) in which he insists that repeated attacks of intestinal colic, especially if accompanied by nausea, may be the only symptoms of the presence of either a renal or biliary calculus, and that this fact should lead the practitioner to investigate the state of the kidney and urine, bearing in mind the possibility of the symptoms being due to renal or biliary calculi.

Spinal Disease. The great difficulty which may arise in diagnosing between certain cases of spinal caries and renal calculus is not yet sufficiently recognised. A writer, already quoted from (G. A. Wright, *Med. Chron.*, No. vi. p. 642), thus alludes to this matter:

"Where a local patch of caries of a vertebral body exists, and especially where deep suppuration occurs and presses upon the kidney, as in a case of my own and one or two others which I have seen, nearly all the symptoms of a calculus have been present. In my own case, without any deformity or tenderness of the spine, there was unilateral rigidity, testicular pain, intermission of symptoms, increased frequency of micturition, nausea during attacks, and oxaluria with local pain and tenderness. Subsequently an abscess developed, and on exploration a small patch of caries was found, and the kidney was felt exposed in the anterior wall of the abscess cavity. Probably, as in floating kidney, obstruction of the vessels and ureter may arise and cause symptoms, so that pressure of the spinal abscess may disturb the kidney, and quite possibly give rise to hæmaturia."

Interstitial Shrinking Nephritis.—This condition may simulate renal calculus both by hæmaturia and pain.

Dr. S. West (*Lancet*, 1885, vol. ii. p. 104) drew attention to the hæmaturia which may accompany granular kidney, and published three cases, aged twenty-one, nineteen, and twenty-four; in the first the hæmorrhage was profuse. Mr. Bowlby (*Clin. Soc. Trans.*, vol. xx. p. 14) also published three cases, aged seventy-three, forty-nine, and sixty-four; two of these died, and the kidneys were found markedly granular. He points out the following as distinguishing this condition from renal calculus:—The specific gravity of the urine, after the blood has cleared up, only 1008 to 1015; tortuous arteries, cardiac hypertrophy, and high arterial tension; blurred, ill-defined discs, some retinitis and effusion amongst the blood-vessels. The paper concludes with the following warning: "Unless it be recognised that blood may emanate from a kidney which is simply granular, operations may be undertaken for the removal of renal calculus."

With regard to renal pain in granular kidney, this is of two kinds. There is the dull aching generally found, if the case be watched, to be felt across both loins, as well as in one side. Occasionally, though this is rarer, the pain occurs in violent paroxysms, simulating renal colic. This was so in the case to which I have alluded at p. 715, and to a more marked degree in one brought by Mr. Mansell Moullin before the Clinical Society (*Trans.*, vol. xxv. p. 60). If now, in addition to the hæmaturia and paroxysmal pain, there be nausea, passage of uric acid, and frequent micturition, the mistaken diagnosis of calculus may easily be made. Where granular kidney is possible such a case should be carefully attended, and if the specific gravity of the urine never rises above 1015, the question of operation must be entertained with the greatest caution, and the very great risks most clearly put before the patient.

I have only space just to mention two other conditions which may simulate renal calculus; they are:

Growth of the Kidney in its Early State, Cystic Kidney, and Malignant Disease, involving the last Dorsal Nerve.—I have already, at p. 715, quoted cases belonging to the second and third groups here given, which will show how closely the presence of renal calculus may be simulated, and how misleading evidence may be.

Operation.—The patient being in much the same position as that for lumbar colotomy, on the sound side, with a firm pillow under the opposite flank, the surgeon defines, carefully, the lower border and length of the last rib. That this is not an unimportant detail in renal operations is proved by the following:

Prof. Dumreicher,* of Vienna, accidentally opened the pleural cavity during an attempt to remove a pyo-nephrotic, calculous kidney. At the autopsy it was found that the last rib was rudimentary, that the pleura projected a good deal below the lower edge of the eleventh rib, and that thus, when the incision was carried upwards, the accident had become unavoidable. Dr. Lange, of New York, has called attention to the investigations of Dr. Holl,† of Vienna, on the frequency of rudimentary development of the last rib, and the importance therefore, of counting the ribs before intended operations on the kidney. Dr. Lange himself shows that, in some cases, which are, however, exceptional, even normal development of the twelfth rib may demand extreme caution, as the pleura may project considerably below it.‡

* Quoted by Dr. Lange, *loc. supra cit.*

† Dr. Holl found that in quite a considerable percentage the last rib is so abnormally short that it does not reach as far as the outer border of the sacro-lumbalis, or so rudimentary that in some cases it more resembles a transverse process; that in these cases the lower edge of the pleura passes from the lower boundary of the last dorsal vertebra, almost horizontally, towards the lower edge of the eleventh rib.

‡ *Annals of Surgery*, vol. ii. October 1885, p. 286.

§ In other cases the reverse condition may be present; though the last rib be rudimentary, the pleura may pass from the lower edge of the eleventh dorsal vertebra horizontally towards the eleventh rib, and thus be altogether out of danger.

The surgeon, having defined the length and position of the lowest rib, makes an incision,* at least 4 inches long, $\frac{1}{2}$ inch below it, and beginning about $2\frac{1}{2}$ inches from the spine. The skin and fasciæ being divided, the muscles—viz., anterior fibres of the latissimus dorsi, the external and internal oblique—are cut through, either on a director, or simply by light sweeps of the knife. As soon as the yellowish white lumbar fascia is reached, any bleeding vessels which have been temporarily secured with Spencer Wells' forceps are tied or twisted. If the last dorsal nerve cross the incision, it, together with its accompanying vessels, should be drawn aside and left untouched if possible. The lumbar fascia is next slit up on a director. The peri-renal fat which now bulges into the wound is torn through. With two large retractors opening up the wound, the surgeon continues to tear through the above fat† till he can see or easily feel the posterior surface of the kidney. Injury to the peritonæum (p. 730) is best avoided by keeping close to the outer edge of the quadratus lumborum. During this first stage of the operation the surgeon will find sometimes that the muscles are much thickened by reflex irritation from the presence of the stone, and, if the stone has been combined with suppuration and peri-renal inflammation, the tissues will be more or less densely blended and matted together.

An assistant now makes powerful pressure on the opposite side of the abdomen, so as to keep the kidney up into the wound, this being widely opened by full-sized retractors, aided, if needful, by an assistant pulling up the lower ribs with a hand previously made aseptic. Thus the surgeon is enabled to examine the organ, which is done systematically; the finger is first directed to the pelvis, then the posterior surface; next, by passing the finger round the outer border, the anterior surface, which, as Mr. Howse has pointed out (*Clin. Soc. Trans.*, vol. xvi. p. 93), can be done effectually by pressing the kidney back against the firm, unyielding psoas. The sensation given by a stone has been compared to that of the uncut end of a pencil (Morris), or the last joint of a finger (Howse).

If the above means fail, the incision must be made sufficiently free, especially in a fat patient, and a deep loin, to expose the kidney more thoroughly. Additional room may be gained by converting the usual lumbar incision into a T-shaped one, or by making use of König's incision, in which the muscles are cut through as far as the rectus, and the peritonæum pushed forwards. A small stone in a kidney will always be liable to be overlooked, but a surgeon does not give his patient or himself a fair chance who is content with exposing part of the kidney through a limited incision, and then trusting to punctures with a needle.

* The parts being previously cleansed according to the directions given at p. 657.

† If this fat is very abundant, some of it should be carefully torn away; poorly vitalized, it is prone to suppurate tediously and to delay healing.

If the stone cannot be felt either in the pelvis or after palpation of the posterior and anterior surfaces of the kidney, this should be drawn up and out of the wound as far as possible, and again examined, a careful watch being kept upon the pulse.

If no stone can be felt by the exploring finger, a needle firmly held in Spencer Wells' forceps should be thrust into the different parts of the organ, exploring it by successive punctures made at short distances; twelve or more such punctures may be made.

All the above, including palpation of the kidney between the finger and thumb, failing, the kidney itself must be incised and explored with a sound. The kidney may be opened either near the pelvis* or at its outer border; whichever spot is chosen, it is best to puncture boldly with a straight bistoury and then to dilate with a finger. The opening having been dilated sufficiently, if the finger detects nothing, a child's bladder-sound is introduced, and an attempt made to explore the calyces systematically. In the case of a small stone lying deeply in the substance, the upper part of the kidney, perhaps well up under the ribs—and it is these stones which are, I think, most often missed—the click which a sound gives is very faint and distant. It is to Mr. Jordan Lloyd (*Pract.*, vol. xxxix. p. 173) that we owe directions for systematically exploring the kidney, and it is to his method that I owe my finding the stone in case No. 8 of the table at p. 745, where the calculus lay, not in the pelvis, but deeply embedded in an upper calyx. The following are Mr. Lloyd's words:

“When the kidney is exposed through a lumbar wound I puncture its lower end with a long-bladed tenotome in a direction upwards and inwards, making for the lowest of the calyces. If the surgeon is observant and his knife is keen he will readily appreciate the moment when a cavity is struck by the altered

* In the following case, under the care of Mr. T. Jones, of Manchester (*Med. Chron.*, June 1887, p. 212), this step of opening the pelvis alone sufficed to find the stone, after systematic exploration of the kidney had failed: “The fore-finger was passed to the anterior surface, and the organ grasped between the finger and the thumb; nothing, however, could be found. The kidney was then carefully explored by systematic puncture with a long needle, also passed towards the pelvis, but no calculus could be felt. An incision, sufficiently large to admit the tip of the index-finger, was then made through the kidney substance into the pelvis by means of a fine bistoury. On introducing the fore-finger, a small stone was discovered firmly lodged in one of the superior calyces. Small, straight lithotomy forceps were introduced, and the stone thus removed.” Very free hæmorrhage attended the above incision, but it yielded to pressure made with carbolised sponges and kept up for five minutes. The patient made a good recovery. The calculus, consisting of lime oxalate, weighed twenty grains. This plan of opening the pelvis might be thought to cause a risk of leaving a urinary fistula, but the numerous cases in which calculi have been removed from the renal pelvis with entire success do not support this view. If the pelvis be dilated this spot should be chosen, otherwise I generally incise the convex border at its lower part, as a spot more readily kept under notice, if much bleeding follow.

resistance offered to the puncturing instrument. . . . It is important, because a tenotome may be pushed up to its handle in a normal kidney without tapping its interior cavity, having travelled *along* the kidney substance rather than *through* it. Into this opening I pass a child's bladder-sound, and systematically explore the whole of the pelvis." It is advised that the beak should be not more than one-third of an inch in length, a stem of about 7 inches, and the size of a No. 3 English catheter. It should be passed at once to the top of the kidney cavity, a distance of nearly 4 inches, and the exploration should be carried out systematically from above downwards, the point being rotated in all directions, so as to investigate the calyces as the instrument is withdrawn. Hæmorrhage from an incision into the kidney is usually free, but is arrested by the exploring finger or by holding the lips of the wound around the sound. Later on it is stopped securely by firm, careful plugging with strips of sal alembroth gauze. On the five occasions on which I have used this plan I have removed the strips the next day with the aid of a few minutes' anæsthetic, gas sufficing for this. It is said that this plugging may cause vomiting. This did not occur in any of my cases. It would cease on the removal of the plugs. Care must be taken that the plugging is thoroughly done. If inadequate it will have to be repeated in a few hours—perhaps more than once—thus leading to exhaustion and setting up cellulitis, which may of itself be fatal, owing to the important relations of the kidney. One such case of retro-peritonæal cellulitis and suppuration, ending fatally, has been published; it is possible that other operators may not have been so candid. In my later cases I have not resorted to plugging any incision I may have had to make. I have only had occasion to regret this one, the case (No. 19 in the table, p. 745) in which the patient had a contracted mitral valve.

The position of the calculus having been made out it is removed by scraping through the kidney tissue with the finger-nail or sharp spoon, and the stone turned out and removed with finger, dressing-forceps, or scoop. Many difficulties may arise at this stage, due to the site, size, consistency, &c., of the stone.

If the stone is irregularly branched, some laceration of the kidney tissue may be spared if the stone is broken up and removed in two or more fragments. In this case the bed of the stone should be freely washed out with hot boracic-acid lotion or Thompson's fluid,* so as to check oozing and remove all *débris*.†

* Water, 4 oz. ; glycerin, 4 oz. ; borax, 2 oz. To be diluted with water to 1 in 10, or 1 in 4, according to the condition of the part syringed. Solutions of carbolic acid or mercury perchloride should be avoided in such cases, for fear of irritation or absorption. The temperature of the fluid should be about 110°.

† Mr. Kendall Franks (*Lancet*, 1880, vol. ii. p. 1223) thus removed, piecemeal a friable stone weighing 171 grains, and composed of lime carbonate and phosphates. In this case the urine had been fetid, though acid. The wound healed

Mr. H. Morris (*Brit. Med. Journ.*, Nov. 16, 1889) thus alludes to two difficulties which these stones may cause. "A large branched calculus may be so tightly embraced by the kidney substance, and the kidney may be so uniformly even on its surface that nothing more than a very firm tough organ may be thought to be present, and even on passing a needle into it no sense of calculus, but rather the resistance of a tough fibroma, is met with. In these cases much difficulty will be experienced in freeing the stone from its encasement, and for this purpose the moderately free use of a bistoury will be requisite. It is astonishing how some of the large branches of a calculus may escape detection unless the surgeon is aware of the firmness with which they are embraced by the tough renal tissue. After removing several large pieces of calculus, I have, in one or two cases, thought that all must have come away, because with my finger in the kidney nothing but renal tissue could be felt, and yet, after scratching through at some points where the resistance was greater than elsewhere, branch after branch of calculus has been exposed, showing that more of the calculus would have been left behind than had been removed had the operation been discontinued, because no further actual contact with the calculus was made with the finger in the interior of the kidney."

If the kidney be enlarged with expanded calyces the result of calculous hydro-nephrosis or pyo-nephrosis, on searching through the pelvis after a stone, the gush of fluid and collapse of the expanded kidney may cause the stone to disappear, and thus lead to much trouble in its removal (Symonds, *Clin. Soc. Trans.*, vol. xviii. p. 181).

Mr. Morris (*loc. supra cit.*) gives two other conditions which may prove embarrassing. "Sometimes in feeling over the kidney a portion of it, varying in size from a sixpence to a five-shilling piece or more, is found soft, flaccid, thin or fluctuating, and there is nowhere any sense of hardness or increased resistance, such as might be expected from even a phosphatic stone. On incising or puncturing this soft part, pus or purulent urine is drawn off, but no stone is felt; but on introducing the finger into the interior of such an organ, a small calculus may be detected, freely movable within an enlarged pelvis, or fixed in a dilated calyx, or possibly at the apex of a funnel-shaped pelvis. Such cases show that aspiration, or simple incision and drainage, are insufficient, and that one ought not to be satisfied with anything less than a digital examination of the interior of the pelvis, of the calyces and commencement of the ureter. Another arrangement of the calculus is sometimes found in sacculated kidneys. The renal cavity may be wholly or partially filled by a soft, mortary, phosphatic calculus which gives no sound or

by first intention. In cases of piecemeal-removal of calculi, especially when friable, a certain amount of doubt will often remain as to the entire removal.

resistance to the scalpel or trocar, and yet, on incising the renal substance and inserting the finger, a stone of considerable size may be felt."

One more difficulty which must, however, I think, be a very rare one, is inability to reach the pelvis in a stout patient. Mr. Mansell Moullin relates (*Clin. Soc. Trans.*, vol. xxv. p. 57) a case of this kind:

The patient, a lady, aged about forty, and rather stout, had suffered for ten days from total suppression of urine, believed, and correctly so, to be due to a calculus having blocked the upper end of the ureter of the only kidney which remained functionally active. The left kidney was explored by the usual lumbar incision. There was no difficulty in finding the kidney, although it seemed to lie unusually deep. Its surface was smooth and uniform, but very firm, and it was not possible, either by rolling the patient on to her back, or by hooking the kidney outwards, to pass the finger sufficiently far on to the anterior surface to feel the pelvis. The kidney was punctured and explored by dressing-forceps and sound, but no stone detected. The operation was successful in that urine soon began to escape, but the patient sank with pyelitis and increasing asthenia on the twenty-third day. The autopsy showed no trace of a right kidney. The left was much enlarged, and an oval uric-acid calculus was impacted in the ureter at its commencement, lying nearly in the middle line of the body.

If the kidney has been much disturbed during the operation it should be stitched *in situ* (p. 773). And it is possible that this step, taken earlier during the operation, might facilitate matters—*e.g.*, when multiple stones are present, and the kidney movable.

When all the stone has been removed, if free oozing continues from the kidney, a full-sized drainage-tube should be introduced to the very bottom of the wound, and actually into the kidney itself; if this has been much lacerated, or if it has contained pus, strips of sal alembroth or iodoform gauze should be carefully packed into the wound in the kidney. These should be removed in twenty-four hours, ether or gas being given for a few minutes, and re-introduced, less firmly, if needful.* The ends of the wound only should be sutured. I generally use a little iodoform gauze wrung out of carbolic-acid lotion (1 in 20), then the same gauze dry, and over this salicylic wool firmly bandaged *in situ*. Sal alembroth gauze and wool are, I find, liable to cause irritation where the parts are constantly moist. Whatever dressing is used will have to be changed two or three times daily, for, in all probability, three or four days, owing to the soakage of urine. To reduce the irritation of this to a minimum, the parts around the wound should, after the first week, be well smeared with eucalyptus and vaseline.

A stone may be missed at the operation and come away from the wound, and be passed later on *per urethram*. An instance of the former is given by Mr. Bruce Clarke, *Illus. Med. News*, p. 4. The latter happened to me in case No. 9 in the table (p. 745).

* If such plugging has to be made use of, it should be carried out effectively and once for all, otherwise recurrent bleeding and repeated plugging are very likely to lead to cellulitis, which may end fatally, to say nothing of the painfulness and shock caused by repetition of the plugging, unless an anæsthetic is given.

After-treatment.

The chief points here are: 1. The meeting of shock after a prolonged operation. 2. Changing of the dressing at sufficiently frequent intervals at first, according to the amount of urine and blood which soak through. 3. Gradual shortening of the drainage-tube instead of entire removal, especially where there has been much interference with the surrounding parts, or where pus, &c., have been present in the kidney. 4. Avoidance of all chills. 5. Appropriate food, mainly the blandest fluids in regulated amounts, especially where the condition of the other kidney is doubtful.

Lastly, it may be pointed out that the life-histories of these cases should be followed up most carefully, to see how far the cure remains a complete one; to aid this, the patient should pay life-long attention to his diet, habits, exercise, &c.

Difficulties in Nephro-Lithotomy.

1. An insufficient incision. 2. Abundant fat—*e.g.*, in the subcutaneous tissues, around the kidney, and extra-peritoneal, rendering the wound very deep. 3. Rigidity, and perhaps thickening, of the muscles, due to the irritation of the stone. This condition was present in a very marked degree in a patient from whom I removed the smaller calcium-oxalate calculus (Fig. 178). No amount of anæsthetic seemed to have any effect on this condition. Fortunately the loin was a thin one, and the stone very obvious on reaching the pelvis. 4. Matting of the parts around the kidney, rendering it difficult to explore this organ, its different parts and relations exactly. 5. An indurated condition of the kidney itself from the irritation of a stone. 6. Troublesome flatulent distension of the colon. This is not at all uncommon. The bowel should be packed away with sponges fastened on to silk, and pushed deeply into the front of the wound. 7. Opening the peritonæum. This accident occasionally occurs in difficult cases. If the wound be kept aseptic, there will be no serious consequences.

In case 11 of the series below, I opened the peritonæum under the following circumstances: The week before, in No. 10, the kidney lay very high up under the ribs. In No. 11 it was placed very low, closely surrounded by the colon, and with its lower end in the left iliac fossa. It was also the seat of a small hydro-nephrosis, and therefore soft and yielding. On slitting up the lumbar fascia the descending colon came into view with a soft mass behind it, which I took for pultaceous fæcal contents. I accordingly explored with my finger higher up, and under the ribs, found a body firm and fleshy, with a feel like the kidney, but too small. This proved to be the spleen, unusually movable. The opening in the peritonæum was kept covered by aseptic sponges, and the mass behind the colon investigated. This proved to be the kidney, extremely low down, containing a calculus in the pelvis, this last being also distended with fluid. For the first few days I kept strips of sal alembroth gauze, changed two or three times in the twenty-four hours, tucked up under the ribs, and stitched the low-lying kidney well up into the wound, so that the urine should escape freely. The patient recovered without a bad symptom. Smaller openings should be tied up with chromic gut, or sutured with the same.

8. A stone present, but very difficult to detect. This may be

due to (a) its small size, especially if it lies deeply in a calyx, or is surrounded by very indurated kidney tissue. A very small stone may cause severe symptoms. This was proved by some of the cases in the table given at p. 745.

Thus, in case 5, a stone, weighing but 14 grains, and situated in the top of the ureter, quite incapacitated the patient from any work. In case No. 8, another very small stone, firmly fixed in a calyx at the upper part of the kidney, caused severe hæmaturia and pain.

The following case under the care of Dr. Murphy, of Sunderland (*Brit. Med. Journ.*, vol. i. 1891, p. 757), shows still more clearly what urgent symptoms a tiny calculus may cause.

The patient, aged thirty-nine, had been a complete invalid for nine months, owing to repeated attacks of renal colic, which morphine failed to relieve, the administration of chloroform being frequently required. At the operation, "a very small stone, about the size of a hemp-seed, escaped with a flush of blood" when the kidney was incised. The site of the stone is not given. A good recovery followed.

How impossible it is to detect some stones, even when of fair size, is shown by a case published by Mr. Morris.*

This authority, with all his experience, after thoroughly exploring the kidney, compressing it all over with the finger and thumb, and also after puncturing it, failed to detect a stone which lay in a hollowed-out calyx. Though the calculus was the size of a small marble, it was so thickly surrounded by kidney-tissue, that, even after the removal of the kidney, the position of the stone could not be detected by pressing on the kidney with the fingers as it lay on a table. The patient made a good recovery.

(β) A sacculated kidney, into one of which sacculi a small stone may fall and be hard to find (p. 728).

9. A stone on the anterior surface of the kidney, especially if near the entrance of the vessels. 10. A very large or a branching stone (p. 727). Mere size does not necessarily create difficulties in extraction, though, owing to the changes entailed in the kidneys, the general health, &c., by the long duration of a calculus, the prognosis is rendered very much less favourable. Thus, in the calculus (Fig. 178) weighing 473 grains, or very nearly an ounce, the very bulk of the stone rendered its detection easy; it was readily loosened from the much dilated pelvis with lithotomy-forceps. A branched calculus presents, of course, much greater difficulties (p. 728).

Mr. Bennett May has published (*Clin. Soc. Trans.*, vol. xvi. p. 90) an excellent instance of this kind, in which he successfully removed a very large somewhat S-shaped calculus from a man aged thirty-four, with symptoms of sixteen years' duration. Though the stone weighed 473 grains, and was three inches long, manipulation failed to make it out distinctly, but acupuncture detected it at once.

Mr. Footner, of Tunbridge Wells, removed a calculus weighing 822 grains, or nearly 2 ounces. The patient made a good recovery, but a sinus persisted, through which, on two occasions, a millet-seed calculus was passed (*Brit. Med. Journ.*, 1892, vol. ii. p. 69). A calculus far exceeding the above was brought by

* *Med.-Chir. Trans.*, vol. xlviii. p. 69. The woodcut (p. 73) shows well the relation of the stone to the surrounding kidney.

Mr. D. Day, of Norwich, before the Clinical Society (*Trans.*, vol. xxvi. p. 24). This calculus, mainly phosphatic, weighed 1331 grains. The patient made a good recovery, with a sinus persisting in the loins. A calculus larger than either of these is mentioned at p. 736.

11. A stone which breaks up readily (p. 728). Another condition allied in difficulty is where a calculous deposit rather than a distinct calculus is present. This is more grave, as the deposit here will usually be phosphatic, and point to co-existing pyonephrosis. 12. Multiple calculi, as in the case at p. 733). Stones (usually minute in size) numbering over 60 or 100, have been removed on several occasions. In such cases it is always possible that the minute calculi have been retained, owing to a larger calculus—*e.g.*, in the pelvis or ureter, blocking their exit. 13. A very mobile kidney. The importance of having an assistant to push the kidney well up into the wound has already been insisted on. It is essential to have this done both for detection of the stone and for its removal, in order to avoid needless disturbance of the surrounding parts, or the kidney may be secured with sutures at the commencement.

Mr. May (*loc. supra cit.*) explains the remarkable fact that his large stone was not felt when the kidney was thoroughly exposed by the fact that the organ fell forwards and thus embarrassingly increased the depth of the wound.

14. A kidney situated very high up under the ribs (p. 730). 15. A kidney, the pelvis of which it is difficult to reach owing to the stoutness of the patient, as in the case given at p. 729.

Question of Nephrectomy during a Nephro-lithotomy.—In several of the above conditions the question of the advisability of removal of the kidney will arise—*e.g.*, where the kidney has been much handled and repeatedly incised, where the stone is large and branched and difficult of removal, where many stones are present, or where one is present and very friable, where the kidney is much altered by pyo- or hydro-nephrosis, and finally where the surgeon is certain a stone exists but cannot find it, as in Mr. Morris's case already alluded to at p. 731.

In such cases the surgeon will be guided by the age of the patient; the knowledge he possesses as to the condition of the other kidney (the amount of urine, the percentage of urea, &c.); the degree to which the kidney he is operating on has been disturbed from its relations, and its structure interfered with; the amount of disease, *e.g.*, number of sacculi, condition of pus contained in them, the thinning of the cortex, &c. When the surgeon is certain from the history and failure of previous treatment that a stone exists which cannot be found, he must be chiefly guided by the degree to which life has been made miserable. Finally, the length of time that the operation of nephro-lithotomy has already lasted, and the condition of the patient must be taken into account. Where the patient is young, where the other kidney is healthy, where the kidney operated on is much damaged either by previous disease or by manipulation added to disease, where several stones

are present, nephrectomy either now, or a little later, is indicated ; of these immediate removal of the kidney is preferable if the patient's condition admits of it.* But the question is a very different one where the kidney is a large one after its fluid contents as well as a stone have been removed ; or where it is a case of multiple calculi in a suppurating, damaged kidney. Nephrectomy should, as a rule, be deferred here, and the kidney thoroughly drained, for (1) additional shock and loss of blood will be avoided. (2) The condition of the opposite kidney, very possibly calculous also, will be made clearer by waiting. (3) The bulk of the kidney will be lessened by drainage. (4) Though a source of discomfort (if an open sinus persist) it may still do some and important work.

Causes of Death after Nephro-lithotomy.—Very few unsuccessful cases have been published ; the following appear to be most probable causes of after-trouble :

* An instructive case which was under my care illustrates well many of the above difficulties—viz., multiple and large calculi, a mobile kidney, the question of nephrectomy arising during nephro-lithotomy, and the formation of multiple calculi in one kidney without symptoms. In February 1888 I was asked by Dr. Goodhart to see a case of probable renal calculus. The boy, aged fifteen, had been admitted with abdominal pain and grating of an indistinct and delicate nature in the left renal region. This kidney was slightly enlarged. When asked to localise his pain, the patient pointed to the region of the *left* kidney and the *left* loin. This kidney being explored was found to be occupied by irregular nodulated masses. A hare-lip pin at once came on and between calculi. The kidney being incised, hosts of calculi, comparable only to a gravel-pit, were found in the calyces and pelvis, the chief nests being at the upper and lower extremities. The former of these, lying as they did high up under the ribs, gave much trouble. To get at them the kidney-tissue was again scraped through directly over them, and many of them thus reached. The chief difficulty of the operation, in addition to the number of stones, was the great mobility of the kidney, though this organ was well pushed up from the front. The condition was perhaps due to the almost entire absence of surrounding fat. When I realised the condition of the kidney, I expressed myself in favour of nephrectomy, as the organ was almost useless, as the stones were so numerous, and as a prolonged attempt at removal would produce more shock in so weakly a subject. One or two less important points in favour of nephrectomy were the mobility of the kidney and entire absence of adhesions. Dr. Goodhart's counsel was, however, against this step, owing to the small percentage of urea—this had never been above 1·2 per cent., and often less. I accordingly continued ; when forty-six calculi had been removed, and the operation had lasted three-quarters of an hour, the pulse failed so ominously that I was obliged to desist. Very little blood escaped as long as the opening was plugged with the finger, but considerable oozing followed as the finger brought out the stones. The patient never rallied well, and died three hours and a half after the operation. The autopsy showed a little ecchymosis around the left kidney ; this still contained calculi at its upper and lower parts. The *right* kidney, of which the boy had never complained, also contained a large number of stones. Its substance, though much wasted, still contained a fair amount of secreting substance. The condition of the opposite kidney thus abundantly justified my old friend's opinion. Feeling that unsuccessful cases of nephro-lithotomy have not been sufficiently published I brought this and the case at page 735 before the Clinical Society. A detailed account of each will be found, with ten others, in the *Transactions*, vols. xxii. p. 198 and xxiv. p. 155.

1. Hæmorrhage. A most interesting case of hæmorrhage, fatal on the seventh day after nephro-lithotomy, was brought before the Clinical Society (*Trans.*, vol. xxii. p. 214), by Dr. Stevenson and Mr. Butler Smythe.

Several small and one larger stone (this one being tightly fixed in the pelvis and ureter) having been removed from a kidney, the site of hydro-nephrosis, the patient did well, save for a temperature which was 103° on the third and fifth days, and all along very variable, until the sixth day, when bright blood and urine were passed both by the urethra and by the wound. On the seventh day about half a pint of bright bloody urine was drawn off from the bladder, and death took place soon after, with symptoms of internal hæmorrhage. The kidney was found enormously distended with blood-clot and bloody urine. The opening made at the operation was small and blocked up by clot. Embedded in the kidney substance, close to the pelvis, was a round spiked calculus, which had ulcerated into a branch of the renal artery just at its entrance into the kidney, and had given rise to profuse bleeding into this dilated organ.

The following possible causes of hæmorrhage after nephro-lithotomy must also be remembered :

In case No. 19, in the table, p. 745, the patient was a young Welsh miner, with all the symptoms of renal calculus well marked. At the operation two calculi were easily found and removed from the lower part of the right kidney. About three hours after the operation the usual soakage of urine had taken place through the dressings ; but it was noticed to be unusually brightly stained with blood. When the dressings were removed blood was seen to be trickling through the tube which I had left in contact with the wound made in the lower part of the outer border of the kidney. Dr. Bligh, now of Caterham Valley, and then house-surgeon, plugged the wound, and, the patient passing into a state of collapse, resorted to saline infusion. On my arrival at this time I found that the patient had partially rallied. Similar bleeding followed about two hours later, the wound was replugged and transfusion again resorted to ; but the patient sank 17 hours after the operation. At the autopsy nothing was found in the wound beyond some coagula and ecchymosis round the kidney, and a very small calculus, which I had overlooked when the two others were removed. There was marked contraction of the mitral valve. It is very difficult to estimate the loss of blood in such a case, but it was thought not to exceed 6 or 7 ounces, and there were no coagula. The operation was of the simplest kind, but the marked pallor of the patient's face ought to have led me to inquire for a cause beyond that which I too readily took for granted, viz., the pain, &c., set up by the renal calculi. I am not aware of any case that has been published in which surgical hæmorrhage has been associated with a contracted mitral valve, but I have been given to understand that parturient women with the above lesion are especially liable to the peril of flooding.

Another possible cause of hæmorrhage after nephro-lithotomy is where calculi are associated with a growth in the pelvis. Mr. Battle has recorded a most interesting instance of this (*Brit. Med. Journ.* vol. i. 1895, p. 1206).

At a lumbar nephro-lithotomy several oxalate calculi were removed and a villous growth scraped away from the lower anterior aspect of the pelvis. The patient resumed work, but the hæmaturia returned and became profuse and constant, and the kidney was removed about 18 months after the first operation. The surface about the pelvis was papillated and firm, and the microscope showed evidence of a new growth at this spot, but whether this was a simple papilloma or a squamous epithelioma remained doubtful.

2. Cellulitis. If it has been thought needful to incise the kidney freely, and the bleeding has been arrested with difficulty after imperfect and repeated plugging (p. 727), this may be readily brought on. Other causes of this will be found in much disturbance of the wound or fingering by many hands. Sepsis.

3. Uræmia, if the other kidney is the site of calculous disease or disorganized. This was chiefly the cause of death in the case in which I removed the large stone (Fig. 178).

The patient was a solicitor, aged fifty-eight, of sedentary life, and gouty history, who had suffered from attacks of right renal colic off and on for upwards of thirty years,* these attacks having become increasingly fierce for about six months. Occasionally he had had slight pain on the left side, and on the morning fixed for the operation he passed two small, fawn-coloured calculi of lithic acid and lithates. These were quite insufficient to account for all his suffering, and as prolonged and careful treatment had entirely failed, and as his "life was not worth having at the price," the operation was proceeded with, and the huge renal calculus figured below removed. This was effected with the utmost ease, as the stone, from its size and hardness, was readily detected occupying the distended pelvis of the kidney. A profuse jet of venous blood followed its removal

FIG. 178.



The larger calculus is the one mentioned here in the text. It weighed 473 gr., and consisted of lithic acid and lithates. The main mass lay in the dilated pelvis, the processes fitted into the calyces. The smaller calculus, composed chiefly of oxalates, was successfully removed from a patient aged twenty-four. It weighed 42 grs. The two are good instances of what nephrolithotomy can, and what it cannot do, without grave risks.

with lithotomy forceps, after it had been loosened by a scooping movement of the finger. The hæmorrhage was at once arrested by sponge-pressure kept up for a few minutes. All went well for the first week, save for persistent oxaluria, which no treatment could remove. The patient was able to sit up and read; appetite returned, and the wound was healing well. On the sixth day a change for the worse set in, first much flatulence and nausea, then constant restlessness, followed by coma, ending in death on the morning of the eighth day. I cannot doubt that the opposite kidney was here also the seat of stone, and its tissue too much impaired to admit of recovery, though I was unable to obtain a post-mortem examination to verify this. I should add that the urine in this patient before the operation was acid, of sp. gr. 1018, and without

* This long duration of symptoms was unfavourable. Mr. Keetley was more fortunate in a case equally long standing, in a much younger patient (*Brit. Med. Journ.*, vol. i. 1890, p. 134. A gentleman, aged forty-four, for thirty years had not passed twenty-four consecutive hours without pain. Mr. Keetley removed 150 calculi from the right kidney. A large rough calculus had blocked the way into the ureter for the numerous smooth calculi which formed behind it. The patient made a good recovery.

sugar or albumen. The quantity passed was natural, and the urea sometime normal, sometimes slightly deficient.

Dr. Whipham and Mr. Haward (*Clin. Soc. Trans.*, vol. xv. p. 123) have recorded a case which, with my own just given, point urgently to the importance of surgeons being permitted to explore earlier.

The patient, aged fifty-six, had for "several years" been troubled with "gravel." The symptoms here were chiefly indicative of calculous mischief in the left kidney, but there was some tenderness on the right side as well. The urine here was 1006 sp. gr., alkaline, and contained pus. The left kidney was explored, and found in a state of pyo-nephrosis; no calculus was found, but a copious discharge of pus took place soon afterwards, giving great relief. The patient a little later again lost ground, and the wound was thoroughly explored a second time, but the patient sank a few hours after this, a month after the first operation. The left kidney-pelvis was much dilated in its upper part, and communicated with a large peri-nephritic abscess. The right kidney contained a large branching calculus.

4. Septicæmia. This condition may be induced by the wound becoming foul, a complication which can always be prevented after removal of small stones from healthy kidneys. But where pyo-nephrosis exists, it may be impossible to keep the wound sweet from the first. This was so in Case 6 of the subjoined table.

Here, after removal of nine calculi, I was obliged to remove the kidney a year later, owing to the persistence of a fetid sinus.

And it is to be noted that septicæmia may occur after a nephro-lithotomy, successful as far as the removal of the stone goes, after a considerable interval, where pyo-nephrosis coexists. This is an additional reason for carefully considering the advisability of performing nephrectomy in such cases.

Dr. Shepherd, of Montreal, has published* a very interesting instance of this kind.

Nephro-lithotomy was performed in a patient aged twenty-six, who had suffered from symptoms of stone for seven years, with no tumour, and pus in the urine. An enormous, unbreakable stone of triple phosphate was removed with much difficulty from the left kidney. It weighed 4 oz. and 7 dr., and measured 3½ inches in length and 9 inches in circumference. The tissue of the lower part of the kidney exposed seemed healthy, and no pus being evacuated it was thought best not to remove the organ. The wound continued to discharge pus, and the temperature varied correspondingly for three months and a half after the operation, when septicæmia set in and proved fatal. The autopsy showed that the upper part of the kidney, which was not exposed, consisted of large communicating sacs, containing over 10 oz. of fetid pus, and a number of irregular branched calculi. Dr. Shepherd points out that the fatal septicæmia was undoubtedly due to these abscesses, showing the need of thorough exploration in all cases where a large stone has set up grave changes, and of extirpation in most of them.

I have described lumbar nephro-lithotomy fully because I believe that, on the whole, it is much the safer operation for the great majority of operators. But, to make the account complete, reference must be made to the proposal that **abdominal** should replace lumbar nephro-lithotomy.

* *New York Med. News*, April 23, 1887; *Annals of Surgery*, vol. vi. August 1887, p. 185. The condition of the opposite kidney is not mentioned.

As might be expected, this proposal has come from a specialist in abdominal surgery. Mr. K. Thornton (*Harveian Lectures*, "Surgery of the Kidneys," p. 34) gives the following reasons for preferring his combined method: "Recognising the difficulty in the diagnosis of a stone, and the still further complication introduced by the transference of pain in some cases to the opposite side, and the importance of being able to examine the other kidney and both ureters thoroughly, throughout their whole course, I proposed to open the abdomen by Langenbüch's incision over the suspected kidney, examine carefully both kidneys and ureters, and, having found a stone, to employ one hand in the peritonæum to fix the kidney and stone, and guard the colon, while with the other I could cut down upon the stone directly from the loin, merely making an opening through the loin tissues large enough to introduce the finger and necessary forceps for the extraction of the stone." And again, at p. 36: "We are certain that the patient has the usual allowance of kidneys. The chances of overlooking the stone, if there is one present in either kidney, is reduced to a minimum. I do not say that the abdominal handling is absolutely infallible, but in fourteen operations I have only once failed to find a stone, and the recovery and present health of this one patient make it highly improbable that there was, or is, a stone in her kidney. This result compares very favourably with the large number of unsuccessful lumbar explorations already recorded."

No one who has seen much of lumbar nephro-lithotomy would allow the above remarks to pass uncriticised.

While I am fully aware of the difficulties in determining whether a stone is present, and in what part of the kidney it lies, I am convinced that every year that goes by will perfect our power of diagnosis, by making clearer to us the conditions that simulate stone. "The large number of unsuccessful lumbar explorations" of which Mr. Thornton makes a strong point is not quite correctly referred to by him. He implies that a stone was there, but that operators making use of lumbar nephro-lithotomy failed to find it. Now this is not quite the case. In the great majority of cases no stone was present. They were cases in which the diagnosis was at fault. It has always been so with every new operation, and is one of those faults which time alone puts straight. In reality these failures to find a stone are rather creditable to the lumbar operation. The operators have been of the most varying degrees of experience, and the great majority of their cases* have recovered. Would this have been the case if the explorations had been through the peritonæal cavity with "the necessary manipulations to examine the kidneys and ureters?" Now, on this hangs one of my chief points. No one who knows anything of what Mr.

* I have pointed out (p. 733) that there is reason to fear that fatal cases have not been published. But this would not apply to the lumbar operation only.

Thornton has done for abdominal surgery will doubt for a moment that operations on the kidney through the peritonæum are certain to be as safe in his hands as any such operation can be. But what this book has to try and teach is what operation is the safest for the largest number of operators. I cannot agree with Mr. Thornton that the increased risk due to the opening of the peritonæum is practically nil—*i.e.*, if the surgeon will take the pains to perform a thoroughly aseptic operation. I should agree that the risk of peritonitis is now much smaller than it was, but there are other risks which are inseparable from this mode of exploring the kidney.* I refer to the shock which the necessary manipulations of certain very vital parts must entail. Mr. Thornton will be able to go straight to the kidneys with a minimum of disturbance of the overlying parts. But is it to be believed for a moment that this would be the case with the majority of operators? And this brings me to another point. Others who have tried this method have not found it so easy to detect the presence of a renal calculus or to determine the condition of the kidneys. With regard to the latter point, I may mention the following:

A woman was sent to me with long-standing pyuria of renal origin. She was clearly very near her end from kidney failure, and during the five days she lived no operation was admissible. After her death I thought it a good opportunity to investigate the condition of the kidneys by an abdominal incision. I was able to feel that there was a right kidney, which felt so hard that I thought it contained a stone. About the condition of the left kidney I was quite unable to satisfy myself. The autopsy showed that the right kidney was in a condition of fibroid atrophy; no stone was present. The left was a thin-walled sac containing pus. Owing to the great tenderness on this side, I had looked on this kidney as the source of the pyuria. It would have been readily reached from the loin.

I have only once tried to detect a renal calculus through an abdominal incision.

The case was No. 21 in the table at p. 742. As, in addition to the renal symptoms, there was trouble indicating oophorectomy, I took the occasion, after Dr. Galabin had removed the ovaries, to explore the left kidney, where the presence of a stone was suspected. The existence of a calculus, which felt a large one—in reality three were present—and of a small hydro-nephrosis could be made out. conditions which were verified at the time of the nephro-lithotomy a little later.

In this case the kidney was not enlarged, of the ordinary firm consistence, save near the pelvis, and free from the results of past inflammation. In such cases as these it will always be easy to detect the presence of the stone, but it will be very different in

* Every one who has seen much of renal surgery will know that grave shocks may readily be met with in some of these explorations of the kidney. Thus, in the case of nephro-lithotomy (No. 12, in the table p. 742) in a lady of forty, with fifteen years' history, from whom I removed three cystine calculi, the patient was so anæmic and unhealthy from her long-continued pain and marred life, that she nearly succumbed during the operation. Yet this was of the simplest, the loin thin, the calculi (387 gr.) found at once and extracted easily, the operation itself not exceeding twelve minutes. A.C.E. followed by ether had been given, but the pulse, always weak, became almost imperceptible after the first incision.

those cases where the stone lies in an enlarged kidney, the seat of a collection of fluid, or in one matted down with much thickening of surrounding tissues from long-standing inflammation.

But I would rather quote the opinions of others. Mr. T. Smith (Discussion at the Clinical Society, *Brit. Med. Journ.*, 1887, vol. i. p. 393) said that Mr. Thornton had seemed to represent that by opening the abdomen from the front one could ascertain with certainty whether there was a stone in the one or other kidney. But one could not always tell this, even if one felt the kidney out of the body. In three different cases in which he had handled kidneys so removed no stone could be detected therein until the kidneys were cut open.* Another very interesting case, brought by Mr. Page before the Medico-Chirurgical Society (*Brit. Med. Journ.*, 1888, vol. i. p. 795) shows what care is needed when abdominal exploration for the examination of the kidneys is made use of:

Mr. Page thought that in this case abdominal exploration, had he made it, would probably have led him astray, as the left kidney, which, though small, was the working one, would have been removed, while the right viscus, which was really the seat of pyelitis and contained some small stones, would have been looked upon as merely enlarged to do the work of two, this increase in size being really due to its diseased condition.

Mr. K. Thornton (p. 37) mentions a case in which it took an hour to find the kidney by the lumbar incision, and which ended fatally, and another in which the surgeon failed entirely to find the kidney by the same method. Such cases, as shown by their number, are quite exceptional. When the large number of explorations of the kidney by the lumbar method is considered, it will be acknowledged that the lumbar method is characterised by the ease with which the kidney is found and the well-doing of the cases afterwards, especially when the great number and the diversity of operators are considered.

With regard to pain in one loin due to mischief in the opposite kidney, we have very little knowledge as to sympathy between the kidneys. But this condition is certainly rare. As a rule, in renal calculus pain is alone complained of on the side in which the stone lies. Pain in both loins means usually stones or disease on both sides, a far graver thing than "sympathy."

Mr. Thornton, in his combined method, which I have described at p. 737, lays stress upon the small clean cut which is made upon the stone by the loin, only large enough to introduce the finger and forceps. It is difficult to see how such an opening would suffice to remove a small stone lying in a calyx on the anterior surface of the kidney, one of the most difficult of all cases. By the lumbar operation the surgeon would be able, after freeing the kidney, as is nearly always feasible, to bring it up into the wound, and carefully handle the anterior as well as the posterior surface. With regard to the risk of the hernia which Mr.

* On this point see Mr. Morris's case, p. 731.

Thornton states (*loc. supra cit.*) to be "a not uncommon result of the lumbar operation," the experience of most surgeons will be quite the opposite. As already stated (p. 700), the tissues in the lumbar region are so strong and unyielding, compared with those in the anterior abdominal wall, that a protrusion does not readily take place here.

Exploration of Kidney in Suppression of Urine.—The above condition is so grave when a mechanical cause which medicine cannot avail nothing, is present, the history may be so obscure or perplexing, the call for help so urgent, that some allusion must be made to the subject here. One of the most brilliant examples of what nephro-lithotomy can do in some cases of suppression of urine is shown by a case brought by Mr. R. C. Lucas before the Medico-Chirurgical Society (*Trans.*, vol. lxxiv. p. 129).

The patient, aged thirty-seven, had had her right kidney, a "mere shell containing masses of stone weighing twenty-one ounces" successfully removed. Three months later she was seized with agonising pain in the back and left loin. Suppression of urine quickly set in, and on the fifth day a calculus was removed which was exactly of the shape to act as a ball-valve to the top of the left ureter. The patient made an excellent recovery.

But in many cases of suppression the indications are less clear and there is often much difficulty in deciding which ureter is blocked, owing to the deficient history. An excellent instance of such cases, in which the surrounding difficulties were most successfully met, is recorded by Dr. Fraser and Mr. Parkin of Hull (*Lancet* vol. ii. 1893, p. 688):

The patient here suffering from suppression of urine was seventy-four years of age. Beyond the evidence pointing to obstructive anuria there was very little to throw light on the condition of the kidneys, or which organ should be explored. As the patient had been observed by her friends to support the left side in walking, and as there was deep-seated tenderness in this loin, Mr. Parkin explored the left kidney from the loin. The organ was enlarged, distended, and hypertrophied. About 6 ounces of urine escaped when the kidney was incised along its convex border, the last portion to come away being mixed with serum. No stone was found, and the cause of the suppression must remain obscure as the patient, though seventy-four, made a good recovery, with a sinus from which most of the urine passed.

The above cases show the importance of knowing the history of the case, and, where this is deficient, making a most minute examination, no point being considered too trivial to be pieced in with others, before it is decided which kidney is the working one and now obstructed, and which is obsolete.

Any operative interference should be undertaken, if possible before the stage of constant hiccough and vomiting, twitching or convulsions, and drowsiness deepening into coma, has been reached.

Before alluding to the operative steps to be resorted to it will be well to remember that the causes of suppression of urine which it is thought may be benefited by surgical interference are various in their nature.

No.	Medical Men.	Age.	Sex.	Site of Stone.	Weight.	No.	Result and Remarks.
1	Dr. Hale White	23	M.	Pelvis	grs. 42	1	Recovery.
2	Dr. Wilson, Haverford- west	58	"	"	473	1	Death ninth day. Almost certainly calculi in opposite kidney.
3	Dr. Goodhart	15	"	Throughout kidney	652	46	Death three hours after, opposite kidney a "gravel-pit."
4	For Mr. Dur- ham*	41	"	Pelvis	78	1	Recovery.
5	Dr. Phillips, Faversham	53	"	Top of ureter	14	1	Recovery.
6	Dr. G. Newton Pitt	31	"	Throughout kidney	333	8	Recovery with a sinus. Nephrectomy a year later. Recovery.
7	Dr. Todd, Brigg	29	F.	"	39	9	Recovery.
8	Dr. Cressy, Wallington	22	M.	Calyx at upper part of kidney	22	1	Recovery.
9	Dr. Morley, R.N. Chatham	40	"	?	—	2	I missed both these stones after free incision of the kidney (in two places) and sounding. Both descended a little later. One was passed, the other I crushed. The patient has been perfectly well since.
10	Dr. H. P. Berry, Grantham	33	"	Pelvis	45	—	Recovery.
11	Drs. Fry and Clayton Jones, Shepton Mallet	28	"	"	49	—	Recovery.
12	Dr. L. Stephens, Emsworth	40	F.	"	387 Cystine	4	Recovery. The first and, I believe, the only cystine calculus thus removed.
13	Dr. Pye-Smith	41	"	Pelvis and kidney.	1 oz., 2 gr.	—	Recovery. This patient was admitted with a perinephritic abscess, which I opened. I failed to detect the calculus at this time and removed it about three weeks later.
14	Dr. G. Newton Pitt	14	M.	Pelvis	118	1	Recovery.
15	Dr. Morley, R.N., F.R.C.S.	30	"	"	1 Oxalate	1	Recovery. This was the most difficult case of all. The loin was very deep, the kidney lay very high up, and as I tried to draw it down, it began to tear transversely near the junction of the lower end and the pelvis. Thus the stone, never seen, was removed by the finger. Free bleeding occurred at first few dressings. Pyrexia, puzzling after operation, was attributed by Dr. Dowson (R.N.) to West-African fever.

* This case had been admitted under Mr. Durham, and I operated during his illness. It afterwards transpired that the case had been sent up to Mr. Lucas.

Twenty-one Cases of Lumbar Nephro-Lithotomy—(continued).

No.	Medical Men.	Age.	Sex.	Site of Stone.	Weight.	No.	Result and Remarks.
16	None	23	M.	A calyx	grs. 13	1	<p>Recovery. This calculus was anomalous in site and structure. It was readily detected on the surface by a needle, and, as the kidney felt very hard, I expected a branching calculus. On cutting down on the spot where the grating had been detected I found a very small calculus. This was black in colour, readily crumbling under pressure, and chiefly composed of bloodclot and lime oxalate crystals. During the three years which have followed the operation the patient has had two attacks of colic on the same side. These were much milder than those preceding the operation, and he has been able to continue at his work, but I am inclined to look upon this recovery as probably incomplete.</p>
17	Dr. Pochin of the Old Kent Road	32	F.	Pelvis and kidney. Pyo-nephrosis	—	7	<p>Recovery with a sinus. The kidney here was so diseased that nephrectomy was advised, but deferred by the patient. She has not been heard of since.</p>
18	Dr. S. Sunderland	42	"	Pelvis and kidney. Pyo-nephrosis	—	3	<p>Recovery. When seen two years later there was still pus in the urine. As the disease had lasted over twenty years, it is probable that both kidneys were affected. The scar was quite sound and no enlargement of either kidney was to be detected.</p>
19	Dr. Naunton Davies of Pont-y-pridd	35	M.	Cortex	94	1	<p>Death. A needle detected a small stone in the lower end of the kidney. Incision in the convex border. Venous bleeding somewhat free, but arrested by pressure. No plugging thought needful. Hemorrhage through dressings (no clots), with rapid collapse about three hours after operation. Saline transfusion to four and a half pints, and wound plugged. Rallying of patient. Recurrence of hemorrhage four hours later. The autopsy showed contraction of the mitral valve, p. 734.</p>
20	Dr. Sutton Sams and Mr. Allworth	34	F.	Top of ureter	45	1	<p>Recovery. The kidney, being very movable, was fixed by the method given at p. 774. I saw this patient one and a half years afterwards, and the kidney could be felt fixed in the loin. There has been no return of her trouble.</p>
21	Dr. Galabin	42	"	Pelvis and ureter. Pyo-nephrosis	48	3	<p>Recovery. The chief trouble here was pyrexia and frequent micturition. Dr. Galabin having occasion to perform oophorectomy, I had the opportunity of examining the kidneys. The dilatation of the pelvis and the presence of the stones were easily detected on the left side. The right kidney appeared healthy. A sinus persisted for some months and then closed firmly. When last seen the patient, instead of being a neurotic, exacting, bed-ridden invalid, was in good health.</p>

* Nos. 2, 7, 8, 12, 15, 20, and 21, were private cases. I was responsible for the after-treatment of all except No. 7.

The first and the one most likely to be permanently relieved is a calculus impacted in the pelvis or the ureter of the only working kidney. Another and much less favourable class is that where the only remaining functional kidney is the site of acute inflammation dating to old calculous or tubercular pyelitis. Another class is the traumatic one. Such cases are the following:

Mr. Cock recorded (*Path. Soc. Trans.*, vol. i. p. 293) the case of a young man who died comatose on the eleventh day after an accident. All the symptoms of the original injury and the subsequent peritonitis subsided in a few days, save that the catheter withdrew nothing but blood. The autopsy showed a ruptured single kidney. In Mr. Poland's case (*Guy's Hosp. Reps.*, vol. xiv.), the complete suppression of urine which followed an injury was due to thrombosis of the renal vessels of one kidney, and rupture of the pelvis on the other side.

It will be seen that obstruction by a calculus* is the only one which promises much success to the efforts of the surgeon.

With regard to the operation in the cases of suppression, if the patient's condition is good, and if no sufficient history is forthcoming, the surgeon will be justified in examining the condition of the kidneys by an incision in the linea alba, being mindful of the fallacies to which I have alluded at p. 738. If he finds a stone in one ureter he must either push it up to a part where he can cut down upon it by the safer lumbar operation, or remove it from the abdomen by the steps given below, p. 743. If no stone is found, and it is decided to drain the kidney which seems to be the working one, this should be done by a lumbar incision. It is not only safer for the great majority of operators, but it must always be remembered that in these cases of suppression the working kidney is usually a damaged one, and pyelitis may be present with more or less pus in the kidney.

CALCULUS IN THE URETER.

This is a condition of much importance. There can be no doubt whatever that in many cases where a renal calculus has been diagnosed and no calculus found, the stone has really been in the ureter; as such calculi are probably more frequent than has been believed, and as their removal is often attended with much difficulty, several cases will be given illustrating the different operative steps.

* In very rare cases the ureter may be obstructed by a body, perhaps capable of removal, and not a calculus. Mr. Butler of Guildford records (*Lancet*, vol. i. 1890, p. 79), a case of suppression of urine lasting thirteen days. The autopsy showed that the ureter of the only working kidney (the left one) was greatly distended with urine and plugged by a solid hard body in about its centre. This proved to be a venous thrombus which, formed in one of the veins in the kidney, had passed through a rent in the kidney tissue into the pelvis and ureter. Here the suppression came on four days after a blow on the abdomen. No symptoms had pointed to renal disease, and, save that the blow was on the left side, there was nothing to tell on which side the obstruction was.

A. Cases where the obstruction is high up in the ureter, and within two inches of the kidney.

Here the ordinary lumbar incision, carried forward freely and converted into a T if needful, will suffice, the edges of the wound being thoroughly separated and a good light thrown in. In all these operations the intestines should be thoroughly emptied beforehand.

Dr. Ralfe and Mr. Godlee brought before the Clinical Society (*Trans.*, vol. xxii. p. 155) a case of suppression of urine, caused by the impaction of calculi in both ureters, relieved by operation.

The patient, a lady, aged twenty-six, had had attacks of renal colic on both sides. The left kidney* was first explored, and incised, but no gravel or calculus found. On passing the finger along the ureter a minute hardness was felt about 2 inches below the kidney. A stone having been verified by needle-puncture, it was extracted by a small incision. No sutures† were inserted, but free drainage provided. About a month later, as there was reason to believe that the right ureter was probably still obstructed, the kidney on that side was explored; no stone was found, but a considerable quantity of gravel and mucus was cleared away. The ureter was ascertained to be pervious as far as the iliac vessels by the finger and the passage of fine curved forceps. About two weeks later a small stone was passed *per urethram*. The patient made a good recovery.

Mr. Godlee points out that in a case like this before operation the urethra should be dilated and the orifices of the ureters examined, for careful vaginal examination may fail to detect a comparatively large stone in this situation. Mr. Godlee has shown elsewhere that urine and pus and blood may escape pretty freely past a calculus of very considerable size which is lodged in the middle of the ureter.

Dr. Cabot (*Boston Med. and Surg. Journ.*, vol. cxxiii. p. 247) records a case in which a calculus was successfully removed from a spot in the ureter "about two inches below the kidney."

Here the incision made use of was a longitudinal one along the outer edge of the quadratus lumborum, an incision which by itself is far too cramped for most cases. The stone here, though a very small one, weighing only 2 gr., had caused most acute renal colic, requiring the administration of ether. No sutures were placed in the ureter; a drainage tube was inserted, and urine ceased to leak after eight or nine days. M. Tuffier (Duplay and Réclus, *Traité de Chirurgie*, t. vii. 1892), during a lumbar nephro-lithotomy, in which examination of the kidney revealed no stone, detected a hard oval body about three centimetres long, where the ureter crossed the pelvis. The stone was movable, and was pushed up into the pelvis of the kidney, and removed by an incision in the convex border. The patient recovered.

Dr. Hall (*New York Med. Record*, Oct. 18, 1890, p. 430) records the following case:

* Mr. Godlee points out that, as is the rule, the pelvis was little if at all dilated and the amount of urine contained quite small: the function of the kidney is, in these cases, completely upset by the sudden stoppage of the ureter.

† These are not needed in any extra-peritoneal operations. When they are made use of in any intra-peritoneal operation it is quite possible that if they penetrate the mucous coat—a contingency almost impossible to avoid—and if the urine is alkaline, a stitch may be the starting-point of a fresh calculus.

A woman, aged thirty-six, had had recurrent attacks of renal colic for four years. There had been no hæmaturia. Pain was complained of in the left kidney, which was not enlarged. Examination under an anæsthetic revealed a small swelling in the region of the left kidney, which proved to be the ureter dilated above a stone. By abdominal section a stone could be felt in the ureter about three inches below the kidney. A lumbar incision having been made for its removal, the stone was found difficult to dislodge, this being finally accomplished by a hand in the abdomen. The stone was removed by an incision in the convex border of the kidney. The patient recovered.

In this case a T-shaped incision made sufficiently free in the loin (p. 755) would probably have sufficed.

B. Impaction of a calculus at the brim of the pelvis.

The following case, a brilliantly successful one, by a general practitioner, Dr. Kirkham of Downham Market (*Lancet*, March 16, 1889), is, I believe, the first case in which a patient has been saved from death by suppression of urine by the removal of a calculus low down in the ureter:

The patient was fifty-eight. He had twice suffered from right renal colic, and had passed a small calculus. May 24, left renal colic came on. No urine was passed from this date till after the operation. May 30, the patient was drowsy, with prostration and muscular twitchings. Dr. Kirkham then explored the kidney in the hope that if no calculus was removed life might be saved by affording an outlet to the urine by an incision into the pelvis of the kidney. An incision was made from the tip of the last rib towards the anterior superior spine. No stone being found in the kidney, the exploration was continued along the ureter, in which a stone was distinctly felt about $\frac{1}{2}$ inch above where the ureter crosses the external iliac. There was a little difficulty in reaching the ureter in this part of its course, but after enlargement of the wound a calculus about the size of a date stone was removed. A little urine escaped from the incision into the ureter. No sutures were placed in this. Half an hour after the operation $1\frac{1}{2}$ oz. of urine were passed naturally. Very little escaped from the wound in the ureter, and the patient made an excellent recovery.

C. Impaction of a calculus low down in the ureter.

Here the methods of removal have been very various.

Mr. W. A. Lane has published (*Lancet*, 1890, vol. ii. p. 967) an instructive case of a calculus removed low down in the ureter.

A woman, aged twenty-three, had had symptoms of renal stone for twenty years, but there was nothing to point to the fact that the stone was in the ureter and not in the kidney, except that, associated with her renal pain, she complained at times of pain in the lower part of the abdomen on the same side, which did not appear to be reflected. The kidney was explored by the lumbar incision, and nothing found either in this organ or in those parts of the ureter which could be reached from above or per rectum. The pain having returned with its original severity, the abdomen was opened along the left linea semilunaris, and in the portion of the ureter which had not been explored at the previous operation, a small stone was felt. This was forced upwards along the ureter to the crest of the ilium, and by means of a small incision in the side the ureter was exposed and the stone removed. The aperture in the ureter was sewn up by a fine continuous silk suture. No leakage took place from the ureter, and the woman recovered completely, losing all her pain and discomfort.

Mr. Twynam of Sydney published (*Brit. Med. Journ.*, 1890, vol. ii. p. 240; *Clin. Soc. Trs.* vol. xxiii. p. 93) a case of a child, aged eight, where he removed a stone lodged in the ureter, about 2 inches from the bladder, by an incision like

that used for tying the common iliac. The wound was closed (with much difficulty by fine silk sutures), leakage of urine followed, with some suppuration, but a perfect recovery followed. Here the stone had first been detected by an incision through the left linea semilunaris.

Dr. Cullingworth (*Trans. Path. Soc.*, vol. xxxvi. p. 278) relates a case in which there were calculi in both ureters.

A woman, aged thirty, had had pain in the loins, frequent micturition, pyuria, and fever. There was a swelling in the right loin. Vaginal examination detected a stony mass, the size of a walnut, to the right of the uterus, and a smaller and equally hard one by the left side. An incision having been made in the linea alba, a stone was found impacted in the right ureter just above the bladder. The ureter and pelvis of the kidney were much dilated. The stone was removed by an incision into the ureter, much urine and pus escaping. The ureter was sewn up by five interrupted silk sutures. A glass drainage tube was used. Death took place from peritonitis between the third and fourth day. At the autopsy there were 5 ounces of thin fluid in the peritoneal cavity. Both kidneys were enlarged and contained abscesses. There was no evidence of leakage from the sutures in the ureter. There was a calculus in the left ureter.

Dr. Cabot, of Boston (*Amer. Journ. Med. Sci.*, vol. i. 1892, p. 51) suggests that if the hard masses felt per vaginam and taken for enlarged ovaries had been recognised as stones in the ureters, they might have been removed by incision through the vault of the vagina.

Dr. Cabot (*loc. supra cit.*, p. 47) shows that a stone may be safely removed by a vaginal incision, even where it lies in the ureter close to the cervix uteri.

A woman, aged thirty-nine, had for fifteen or sixteen years been subject to attacks of renal colic, always on the left side, and usually followed by the passage of calculi. In the left lumbar region was a distinct tumour about as large as two fists, sensitive on pressure. Vaginal examination showed a little hardness in the left broad ligament close to the cervix uteri. It was about as large as the last joint of a finger, and very sensitive on pressure. A sound in the bladder could be brought within $\frac{3}{4}$ inch of this little mass, but could not be brought in contact with it by the most careful bimanual manipulation. An incision having been made over the calculus through the vagina, just to the left of the cervix uteri, the stone was easily reached, the grating of the knife upon it being distinctly felt during the first incision. After the end which presented had been thoroughly uncovered, it was found that the rest of the calculus was tightly grasped by the tissues above. It broke into pieces in the forceps, and was ultimately removed by passing a blunt hook alongside of the calculus and then over its upper end, and making traction. The moment it came out there was a rush of pus, and the lumbar swelling was found to have disappeared. The patient made a good but slow recovery. A fistula persisted discharging a small quantity of pus, but no urine, showing how much the kidney above had suffered from the impaction of the stone.

Dr. T. A. Emmet (*Prin. and Prac. of Gynecology*, p. 796) also operated successfully through the vagina.

Here the sound in the bladder detected a click. Pressure being made on the stone with a large sound it was cut down upon, the incision being prolonged forward towards the neck of the bladder so as to avoid the peritoneum. The opening was closed with interrupted sutures, and the patient made a good recovery. In another case Dr. Emmet operated by opening the bladder and

removing the stone with a curette from the mouth of the ureter. M. Tuffier has also removed like stones twice by supra-pubic cystotomy.

Mr. K. Thornton (*loc. supra cit.*, p. 31) met with two cases in which the stone was imbedded low down in the ureter.

In one case, in which he removed the kidney, which was pyo-nephrotic and disorganised, he left the stone in the ureter with a perfectly successful result. In the other Mr. Thornton dilated the urethra, and cut the stone out through the bladder, but a ureteral fistula resulted, and the urine was discharged into the pouch of Douglas. The woman went out of her mind and died of exhaustion a fortnight later.

Finally, Dr. Richmond (Cabot, *loc. supra cit.*), having detected a stone in the end of the ureter, covered over by mucous membrane only, dilated the urethra, and removed the calculus with the finger and a tenaculum.

While I do not profess that the above exhausts all the cases of stones removed from the ureter, I hope they are sufficient to make plain the different methods which may be employed in the removal of ureteral calculi.

NEPHRECTOMY.

Indications.

i. Cases of strumous pyelitis or pyo-nephrosis explored previously and drained by nephrotomy, but in which a sinus and discharge persists. Here the kidney should be removed when the following conditions are favourable—viz., the age and strength of the patient, the absence of visceral infection, tubercular or lardaceous, and, if possible, a date not too long deferred, for the additional reason that the kidney will be increasingly matted down and difficult of removal, while its fellow may have become involved in the disease.

On this point I may quote again from my paper on the conditions which simulate renal calculus (*Brit. Med. Journ.*, 1890, vol. i. p. 117):

“I would most strongly urge this course (early exploration of the kidney) with a twofold object: (1) to clear up the case, and (2) to perform nephrectomy if the kidney is found to be the site of so fatal a disease. If I am told of the unwisdom of this step, owing to the probability of both kidneys being affected, I would reply that, as a rule, both kidneys are not affected at an early stage. Thus Dr. Fagge (*Medicine*, vol. ii. p. 488) gives a list of thirteen cases which show ‘the characters of tuberculous disease of the kidney at its commencement.’ In only three of these were both kidneys affected, and in all these tubercular mischief was present in the bladder also. If during this early exploration one or two pyelitic dilatations are found, extirpation of the kidney should be performed while the organ is still small and movable, and before the rest of the genito-urinary tract becomes involved.

“I need not remind my hearers of the miseries which lie before a patient with established tubercular kidney, the results of ulceration of his bladder, with, perhaps, vomicæ in his prostate, and the inevit-

able course downhill—arrested, it may be, for a little while by nephrotomy and drainage.”

My own experience of drainage alone in established tubercular kidney is most unfavourable, the relief being slight and short-lived, and not arresting long the hectic and increasing debility. On the other hand, in four cases in which I have been able to perform nephrectomy early (cases Nos. 8, 12, 13, 16, p. 767) the result has been most satisfactory. In four others (3, 4, 11, 17, *ibid.*), the recovery, though less complete, was very satisfactory. Finally, in two (cases 15 and 22, *ibid.*), the eleventh and twelfth cases in which I have removed a tubercular kidney, the disease was too advanced in both for the result to be satisfactory.

ii. Calculous pyelitis or pyo-nephrosis where the kidney is destroyed by long formation of calculi and consequent suppuration, where numerous calculi exist with sacculation of the kidney, or where a large and branching calculus is so embedded as to resist removal. These indications for nephrectomy have been already considered under the heading Nephro-lithotomy (p. 732), as it is during the performance of this operation that the question of removing the kidney for the above conditions will arise.

iii. A kidney the site of hydro-nephrosis. The treatment here will vary according to the degree to which the disease has advanced. Aspiration, lumbar nephrotomy, and drainage, the edges of the cyst being stitched in the wound, and nephrectomy have, each, been advocated here. Occasionally repeated aspirations are sufficient, as in Mr. Croft's case (*Clin. Soc. Trans.*, vol. xiv. p. 107) in which eight aspirations (through the lumbar region) within four months, between three and four pints being withdrawn each time, sufficed to cure a hydro-nephrosis in a boy aged twelve. It is noteworthy that the case was distinctly traumatic in origin, and that the last fluid withdrawn contained a very large amount of albumen. It is for such cases, especially if the interval between the aspirations lengthens each time, that aspiration should be reserved. This method is, however, so rarely successful that the surgeon will, in advanced cases, have to decide between nephrotomy and drainage, and nephrectomy. It is now acknowledged by the advocates of the former step that it has given less favourable results than were expected. The time taken is usually very great, the frequent change of dressing necessitated by the constant soakage is most irksome, and later the wearing of a lumbar urinal is most inconvenient, leading as it often does to an eczematous, raw area around the sinus. The sinus is liable to become foul and to contain phosphatic material. The tube also, which leads into the urinal from the sinus, easily becomes blocked and causes much discomfort from redistension of the cyst.

In future, nephrectomy will be oftener performed for hydro-nephrosis where the kidney is much altered, either as a primary operation or after allowing a sufficient interval to elapse for shrinking of a large cyst, but no prolonged delay. Where, therefore, the patients are young, with every prospect of a long and active life

before them, where a month's drainage has failed to bring about any considerable diminution in the amount escaping, and where the fluid thus coming away contains but a small amount of urine, and where there is evidence that the other kidney is competent, the cyst and remaining kidney tissue should be extirpated from the loin before it has become more firmly matted to the surrounding parts.*

In cases where the hydro-nephrosis is early and due to movable kidney, nephrorraphy will often suffice (p. 773). In a few other cases the hydro-nephrosis may be due to valve or stricture of the ureter. For an account of the different operations performed for the relief of these conditions, I may refer my reader to a paper by Dr. Fenger, of Chicago (*Ann. of Surg.*, Sept. 1894).†

iv. Certain cases of malignant disease. These fall into two groups, which must be looked at separately from an operative point of view. One group, the *sarcomata*, occurs in children before ten, usually much earlier, before five. In such cases the risks of immediate death from shock, aided often by peritonitis, of early recurrence, or of death from secondary deposits elsewhere, should be put clearly before the parents, together with the certainty of an early death if the growth is left.

The other group, the *carcinomata*, occurs usually in patients past middle age.

In either case, an operation should only be performed in an early stage, while the growth is still internal to the capsule, and while the strength, health, and condition of the viscera are satisfactory. On the other hand, where the history makes it probable that the growth has got beyond the earlier stage, when there is any extension to the lumbar glands or other viscera, when there is nausea, emaciation, or a temperature inclined to fall, the time for operation has gone by. So, too, any ascites or œdema of the lower limb are absolutely contra-indications.

With regard to the frequency of secondary deposits, the fact that Dr. Dickinson‡ found these to be present in no fewer than 15 out of 19 cases strengthens, very decisively, the argument in favour of early operations while these growths are small, at which time, moreover, they can be successfully attacked through a lumbar incision sufficiently enlarged by the steps given at p. 755, or by one made anteriorly.

Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 254) thus speaks on the question of operation in these cases :

"The death-rate on the total number of cases is enormously large, more than 60 per cent., for carcinoma more than 71 per cent. Nor do I think that a study of the causes of death, whether made from the paper of Gross or from the reports of the individual cases, will lead to the opinion that there is a reasonable

* If in hydro-nephrosis, after an exploratory nephrotomy, bloody urine descends into the bladder, the indication for leaving the kidney will be greater, especially if the viscus show a cortex of fair thickness, and is not a mere sac with little if any secreting tissue.

† A very helpful account of the surgery of the ureter.

‡ *Dis. of the Kidney, and Urinary Derangements.*

prospect of largely diminishing it, unless the diagnosis of the disease can be made at a much earlier period than it has been hitherto. The successful cases are, I am sorry to say, much more easily disposed of.* . . . For the operations for sarcoma (from which fourteen survived) . . . we may count two complete cures† in the total number of cases. It is interesting to observe that not one instance of cure, or even of long relief, is recorded in the cases of children.

The results of the operations for carcinoma are even worse than those for sarcoma. . . . Four patients recovered from the operation, of whom two died of secondary growths within two months of their recovery; one was alive and well at the end of two months, the other at the end of thirteen months."

Mr. Knowsley Thornton, in his Harveian Lectures for 1889, writes thus on the subject:

"If we now attempt to summarise our imperfect knowledge of renal sarcoma, we find that it is most common in children, is in them often congenital, in this case going on to a rapidly fatal termination; that when it makes its appearance later, but still in childhood, it runs a much more rapid course than in the adult, more speedily involves surrounding tissues, and is therefore rarely seen at a time when operation can be undertaken with any reasonable chance of eradicating the disease; that even when detected quite early and before there is any sign of its having involved the other tissues, its removal is commonly followed by such speedy recurrence that the operation is barely justifiable. Such recurrence, moreover, is very extensive in its outbreak, and usually leads to an amount of suffering altogether beyond that which is seen when the disease is allowed to run its natural course in the kidney. Turning now to the adult, we find that the disease is most common in the middle period of life, is usually slow and insidious in its early course, and frequently progresses slowly, and often painlessly, for years, before it spreads beyond the kidney, occasional attacks of hæmaturia, and a hard swelling in the renal region, which is, from its weight, apt to become more mobile than a normal kidney, and is therefore likely to be regarded as an innocent condition, being the only symptoms which are at all common. It is worthy of special note that with the two large tumours of the capsule (or of the supra-renal capsule) there was no hæmorrhage; indeed, the only symptom in each case was the tumour, till its size caused indigestion, nausea, &c. There was never any urinary symptom in either case to direct attention to the kidney."

The opinions of the two surgeons just given are quite justifiable from the death-rate of the operation in the past. It presents, in my opinion, too pessimist an opinion for the future. (1) It is probable that while all cases have been classified as alike malignant, carcinomata and sarcomata, some of these growths of the kidney are less malignant than others. Mr. Malcolm, in a most instructive case (*Clin. Soc. Trans.*, vols. xxvii. and xxviii.), pointed out that his success (the child, not quite two at the time of the operation, was in good health two years and four months later) might in part be

* Mr. Butlin, quoting in detail from Prof. Gross (*Amer. Journ. Med. Sci.*, July 1885), thus specifies the results in the cases of the fourteen survivors: "One died of an unknown cause; one was living with recurrence at the end of four months; and five died of the disease in from five to eighteen months of the operation; two were lost sight of; and five were alive and well at the end of seventeen, twenty-two, twenty-three, thirty-five months and five years. The thirty-five months may fairly be stretched to three years, so that we can count two complete cures in the total number of cases."

† Mr. Butlin means by "complete cures" that these cases were alive and well the end of three years after the operation.

due to the peculiarity of the growth. The nature of this remains somewhat doubtful. It was not a sarcoma. Mr. Targett was inclined to look on it as a "malignant adenoma." (2) In addition to the case above quoted, Dr. R. Abbe, of New York, has published (*Ann. of Surg.*, vol i. 1894, p. 58) two very encouraging cases of sarcoma of the kidney, in which nephrectomy was followed by long and, it is to be hoped, permanent success. In one, a child of two years, nearly three years of good health had followed the removal of a sarcomatous kidney weighing $2\frac{1}{2}$ lb. In the second, a child, only one year and two months old, had survived, when last heard of, over two years.*

It is only by a repetition of operations, with all the advantages of modern surgery, that we can tell what nephrectomy can do for these cases in the future. (3) In Dr. Abbe's words: "The question of the advisability of operation is not always the same as one of curability of the disease, either to the patient in whose heart the exhilarating sentiment of hope will always be found, or to the surgeon who may yet hope to perfect methods and results which will alter the discouraging statistics."

To secure this improvement the following points deserve attention. An exploratory incision should be made as soon as obstinate pain and swelling (perhaps revealed by an anæsthetic) call attention to the possibility of a growth, and before time has elapsed for lymphatic infection. Where the case comes before the surgeon in a more advanced stage, he should bear Mr. Malcolm's advice in mind. As in the "treatment of new growths elsewhere, the more definite the outline of the tumour, the more mobile it is, the slower its growth, the better the state of the patient's health—in fact, the stronger the evidence that the patient is only locally affected, the more likely is operative treatment to be followed by prolonged immunity from disease. Cases may be observed, on the other hand, in which the tumour has no definite outline, being fixed to and incorporated with the neighbouring structures, so as to be absolutely immobile, being also of very rapid growth and accompanied by extreme emaciation. Such cases are obviously unsuitable for surgical interference. "Before the operation every precaution should be taken against shock. Thus the limbs should previously be bandaged in cotton wool, the site of the wound only exposed, the head kept low, injections of brandy and strychnine should be ready, ether administered, warmth maintained by operating on a hot-water table when possible, and warm irrigating fluid used. Finally, an assistant should always be at hand to perform saline infusion, and this, if used, should be resorted to before the close of the operation, when the condition of shock may be irremediable."†

* These dates were given by Dr. Abbe to Mr. Malcom (*Clin. Soc. Trans.*, vol. xxviii. p. 287).

† Dr. Abbe strongly advises the use of the Trendelenberg's position as emptying the blood from the growth into more important parts, and the injection of strong coffee and brandy into the rectum after the operation.

During the operation itself the incision must be sufficiently free. The lumbar one, carried very freely forward,* (p. 755), will give sufficient room. The peritonæum will only be opened when the growth is very large or adherent. Where grave shock is imminent, forceps should be left *in situ* for thirty-six or forty-eight hours. It is easy to prevent a child from rolling on to these by packing the patient firmly on either side with pillows in a cot. Finally, as Mr. Malcolm has shown, every vestige of the capsule, and all fat adjacent to it, together with any fat or glands about the renal vessels, should be removed.

v. Certain cases of injury. These are very rare, and fall into the following groups: (a) Where an injured kidney protrudes from a wound of the abdomen, usually the loin. (b) In some cases of non-penetrating wound of the kidney, as when it is ruptured from a fall or blow. (1) Where hæmaturia does not yield to treatment,† the bleeding being well marked, or latent and insidious, giving evidence indirectly of its existence, by the increasing pallor, the failing pulse, impending syncope, and perhaps a swelling in the loin, as in the case No. 20, Table, p. 769. (2) Later on, when the injured kidney is setting up serious suppuration, which does not yield to drainage. (3) For ruptured ureter and traumatic hydro-nephrosis, Mr. Barker has recorded (*Lancet*, Jan. 17, 1885) a most successful case, in which, after other treatment had failed, he removed a kidney three months after the rupture.

The child, aged three and a half, had been run over, but beyond some bruising and one small clot passed there was nothing to point to injury of the urinary tract. Having left the hospital in a fortnight, apparently convalescent, he was, a few days later, admitted with a fluctuating swelling in the right loin. This increasing, was aspirated, the fluid yielding $\frac{1}{2}$ per cent. of urea. The swelling was subsequently drained, and the drainage-tube becoming blocked with phosphatic deposits, and thus causing a good deal of constitutional disturbance, the kidney was removed. It proved to be healthy, the ureter being torn across just below it.

(c) Penetrating wounds. Very rarely indeed nephrectomy may be called for here (1) when hæmorrhage does not yield to treatment aided by exploration and plugging; (2) when a urinary fistula persists after such a wound in certain cases—*e.g.*, when the other kidney is healthy. (d) Gunshot wounds. Owing to the increase of revolver-injuries and recent advances in abdominal surgery, this matter has lately received much attention.‡ Whether

* Dr. Abbe used a similar one in his two successful cases mentioned above.

† In Mr. Rawdon's case (*loc. infra cit.*) nephrectomy was performed for hæmorrhage after an injury, but at rather a later date—*e.g.*, on the seventeenth day after the fall—to prevent blood from entering the bladder and increasing the acute cystitis present. Here the hæmaturia had diminished at first, and then subsequently increased.

‡ As might be expected, American surgeons have not been slow to avail themselves of their opportunities. Prof. Nancrede (*Annals of Surgery*, June 1887, p. 480) suggests that where the renal or splenic artery is cut by a bullet, the

in civil or military practice, gunshot wounds of the kidney are only too likely to be complicated with injuries of the intestines, liver, and spine. When in the course of an exploratory operation in the case of a gunshot wound of the abdomen, the kidney is found to be the seat of hæmorrhage, if uncontrollable by other means, nephrectomy should be performed.

vi. In a very few cases of nephrorraphy. Where nephrorraphy has been properly performed, as *e.g.*, the method given at p. 774, nephrectomy will never be thought of. In a few cases nephrorraphy will fail, owing to the complication of organic disease, as in the instances given at p. 771.

Operations.

These are. A. Through the Lumbar Region. B. Through the Abdominal Wall, and the Peritonæum as well. (a) By an incision at the outer edge of the rectus. (b) By one in the linea alba. C. Through the Abdominal Wall, without opening the Peritonæum. These methods are compared at p. 763. D. A Combination of the Abdominal and Lumbar Incisions. E. Knowsley Thornton's combined Method.

A. Lumbar Nephrectomy.

Operation.

The position* of the patient and the earlier steps are much as those already given in the account of Nephro-lithotomy, p. 724.

When the lumbar fascia has been slit up and the fat around the kidney torn through, this organ should be well thrust up by an assistant making careful, steady pressure with his fist against the abdominal wall: the wound being now widely dilated with retractors, the surgeon examines the kidney, and has next to decide on three points:

(1) Is removal required? † (2) Will more room be wanted? If so, the incision already made slightly oblique and about $\frac{1}{2}$ inch below the twelfth rib, should be converted into a T-shaped one by

viscus should be removed, as gangrene is inevitable. Dr. Parkes (*loc. supra cit.*) November 1887, p. 379), in a case of bullet-wound of the abdomen, having sewn up five perforations of the intestine, found that the left kidney was perforated. The hæmorrhage was very slight at this time. After doing well for twenty-four hours, the patient began suddenly to fail, and died collapsed from hæmorrhage from the kidney. Dr. Parkes regretted that he had not performed nephrectomy.

Dr. C. Briddon, of New York (*Annals of Surgery*, 1894, vol. i. p. 641), in three cases explored an injury to the kidney by a lumbar incision at a date varying from one to four weeks after the accident, and by evacuating bloody urine, fetid clots, irrigating and tamponnading with iodoform gauze, saved his patients from a state of grave peril.

* Additional care should be taken to open out the space between the last rib and the crest of the ilium by the arrangement of pillows underneath the loin, and the precautions given to avoid shock (p. 751), must be taken here.

† This question has already been alluded to in the case of a strumous kidney incised and drained (p. 747); in that of a kidney much damaged by one or more calculi, under the subject of Nephro-lithotomy (p. 732); and in the case of hydro-nephrosis (p. 748).

another made downwards from its centre, or at its posterior extremity, along the outer edge of the quadratus lumborum. Additional room may also be gained by an assistant slipping his hand under the lower ribs and drawing them forcibly upwards.

(3) Is the kidney firmly matted down or no? If there has been no surrounding inflammation, the extra-peritonæal fat, the peritonæum, and colon will be readily separated by the finger working close to the kidney until the pelvis and vessels are reached. But if inflammation has caused firm adhesion and matting down of the kidney to adjacent parts, the altered fat and thickened and adherent capsule must be divided down to the kidney itself and this gradually enucleated (partly with the finger, partly with a probe-pointed bistoury) from out of its capsule, which is left behind.

The only guide in such a case is the tissue of the kidney itself close to which the finger and knife must be kept.

A case of Mr. H. Marsh's well shows this difficulty.

Removal of the kidney could not here be effected, owing to its size* and the firmness with which it was embedded in the surrounding condensed areolar tissue. That part of the kidney which had been exposed was accordingly transfixed with a strong, double ligature, and cut away. Complete suppression of urine† followed the operation, and the patient died in about thirty hours. At the post-mortem examination the remaining part of the right kidney and its ureter were so firmly embedded in dense cicatricial material that they were dissected out only with difficulty. The kidney itself was converted into numerous sacculi, in the walls of which, however, some remains of renal structure could still be traced. The opposite kidney weighed 6 oz. Its capsule was adherent, and there were two or three more cysts on its surface. On section, its structure looked somewhat confused and cloudy, but its condition was not such as to indicate advanced disease.

Mr. Greig Smith states (*Abdom. Surg.*, p. 508) that, in cases of old-standing suppuration with great enlargement, the vena cava and the aorta may be intimately adherent to the capsule. "One such case was met with in the post-mortem room of the Bristol Infirmary; here it was simply impossible, after death, to dissect apart the venous wall and the renal capsule. In another case, for similar reasons, the organ could not have been removed by any proceeding claiming to be recognised as surgical."‡

If further room is still required, this may be easily and effectually gained by making use of additional incisions as recommended by

* Mr. Marsh (*Clin. Soc. Trans.*, vol. xv. p. 142) points out that the state of the kidney here proved to be much worse than there had seemed reason to anticipate. Although it had been impossible to feel it in a very careful examination under ether, it was dilated to a very large size.

† The urine had been horribly fetid, and the sp. gr. never above 1015.

‡ As will be seen from case 22 in the table at p. 769, I injured the vena cava in the case of a large tubercular kidney, very adherent; the most difficult case I have met with. In a case of attempted nephrectomy (*Amer. Journ. Med. Sci.*, 1882, vol. ii. p. 116) the removal of the organ was rendered impossible, not only by its adhesions to the tissues around, but also, as was proved post mortem, to the colon and pancreas as well.

Prof. König, of Göttingen (*Cent. f. Chir.*, 1886, Hft. 35; *Ann. of Surg.*, Nov. 1886, p. 445). This surgeon, having found great difficulty in getting free access to the kidney by the ordinary lumbar incision, cuts through the soft parts vertically downwards along the border of the erector spinæ to just above the iliac crest. He then curves the incision towards the navel, and ends at about the outer border of the rectus, if necessary going through this muscle to the umbilicus. It may be often advisable to make the perpendicular cut oblique, running in a flat curve into the umbilical part. All the muscles are incised quite down to the peritonæum. This method gives a surprisingly free entrance, but it can be much improved by introducing the hand through the perpendicular part of the cut, separating the peritonæum in front and pushing it forwards. Prof. König proposes to call this the retro-peritonæal lumbo-abdominal incision. If sufficient space is not thus afforded, or if, for diagnostic or operative purposes, it is desirable to approach the tumour from the abdominal cavity, the peritonæum can be divided in the transverse cut. If infectious material is to be removed, this peritonæal opening must be carefully looked after.

We do not yet know how far large kidneys can be got out through very free lumbar incisions. I may state here that I twice, in 1890, removed kidneys 8 inches long through the very limited ilio-costal space of little children aged respectively three and three-and-a-half. One was a case of sarcoma, the other of cystic kidney. Both made excellent recoveries; but, as in the former, the renal vein was thrombosed with growth, it was clear that a few months would see the end. In each case the lumbar incision was carried forwards very freely, and the long axis of the tumour brought out in that of the wound.

The danger of ventral hernia is guarded against by using deep sutures, by allowing only gentle movements at first when the patient gets up, and by the use of a support. By these means the risk of hernia may be reduced to a minimum.*

When the kidney has been sufficiently enucleated either out of its capsule, or, together with this, out of the peri-renal fat, the vessels and ureter must be dealt with. The latter should be taken first, as this step, especially if the ureter be enlarged, will facilitate dealing with the vessels.

If the ureter is dilated, and contains foul pus or tubercular matter, the stump should be carefully cleaned out with a sharp spoon and dusted with iodoform, or brought up into the wound with, and retained there by, a suture, for fear of its infecting the wound.

The vessels are then tied in at least two bundles with sufficiently

* It is noteworthy that Prof. Bergmann, of Berlin, whose name is well known in connection with the surgery of the urinary organs, advocated the lumbar operation for the removal of malignant growths of the kidney (*Annals of Surgery*, September 1886, p. 256).

stout carbolised silk,* or chromic gut. This is passed, with an aneurism-needle of sufficient length and suitable curve, through the centre of the bundle, each half of which is tied separately and finally one of the ligatures is thrown round both halves together. In passing the ligatures, they should be pushed well in towards the spine, so as to leave sufficient room between them and the kidney to prevent all risk of their slipping. If the kidney can be raised out of the wound, passing the ligature is much simplified. If this is impossible, the surgeon may find help by having the lower ribs well pulled up by an assistant, while another keeps the kidney well up by pressure against the abdominal walls, light being also thrown in, in case of need, by a laryngeal mirror, or electric lamp. While the ligatures are being tied, and in dividing the pedicle, no tension should be put upon them.

As soon as the ligatures are secured in position, the pedicle is snipped through at a safe distance from them with blunt-pointed scissors. If the pelvis of the kidney contains foul or tubercular pus, and if there is room, a large pair of Spencer Wells' forceps should be put on the pelvis, and the pedicle cut through between this and the ligatures, so as to prevent escape of septic material. The ligatures are then cut short. If any hæmorrhage now takes place, it is probably due to some vessel† not being included, or to an artery having slipped through the knot owing to the parts being stretched at the moment of ligature. In the event of attempts to arrest such hæmorrhage by ligature failing, it must be stopped by applying Spencer Wells' forceps and leaving them *in situ*, or by firm plugging‡ with aseptic gauze dusted with iodoform.

When a pedicle presents especial difficulties from its shortness, thickness, and the way in which it is overlapped by the kidney, a preliminary ligature should be applied and the kidney cut away well in front of it,§ a step which will give access to the vessels

* See foot-note, p. 446.

† Mr. Greig Smith (*loc. supra cit.*) gives the following practical hints as to the vessels:—The veins are a good deal larger than the arteries, and overlap them. At the hilum the veins branch quite as much as the arteries—*i.e.*, four or five times—and the subdivision extends farther towards the middle line. It is very frequent for two or more trunks to represent the renal vein, and sometimes surround the artery. The want of uniformity in the renal vessels is against the possibility of ligaturing the artery and vein separately. In many cases this will be found impossible; in none is it necessary. Indeed, the walls of the veins, by acting as a sort of padding, may add to the safety of ligatures, preventing the thread from slipping. Mr. Greig Smith further states that the only deaths as yet recorded from secondary hæmorrhage were in two cases where the vessels were separately tied.

‡ In one case published in America this firm plugging has been followed by a temporary fæcal fistula.

§ Dr. Lange (New York Surg. Soc., November 22, 1886; *Annals of Surgery*, April 1887) has shown that in a case in which he adopted this course no slough-

and ureter; a double ligature is then applied behind the temporary ligature, which is now removed. Also where the pedicle is very short a portion of kidney may be left to ensure the ligature retaining a safe hold. I was obliged to adopt this course in a case of nephrectomy for calculous pyelitis in which I had removed twelve stones a year before (case No. 7, Table, p. 767). A sinus persisted, which became abominably septic. As the stump of the kidney was fetid, I inserted no sutures, and packed the wound with strips of sal alembroth gauze wrung out of turpentine. The patient made a good recovery.

A modification of the method of leaving a portion of the kidney to form the pedicle may be made use of in cases of kidneys of large size which cannot be brought through the wound. In such cases, the vessels having been secured by a temporary ligature or by a Spencer Wells' forceps, the kidney should be cut away in separate portions, thus doing away with the struggle required in bringing out a large kidney and the risks of producing serious shock by pulling on the vessels.*

Another means of treating the pedicle where this is short and matted down, is to cut it through piece by piece, securing each bleeding point with compression-forceps, and tying them off one by one. Or the vessels may be under-run, as in excision of the knee, but on a larger scale, and more *en masse*.

By such methods as the above the risk of wounding the cava or aorta is avoided. If the amount of kidney left is small, it will no doubt atrophy and give no further trouble, but, if large, some sloughing will probably take place; in such a case iodoform should be dusted on to the stump and free drainage provided.

Another difficulty which may be present now is caused by the kidney having contracted adhesions to the peritonæum and some of its contents.

I have three times opened the peritonæum, when using the lumbar incision; to one case, a nephro-lithotomy, I have alluded at p. 730. The other two were cases of growth and tubercular pyelitis, for which I was removing the kidney. All three cases

ing took place, as the thick, fleshy part of the pedicle beyond the ligatures was gradually absorbed by the healthy granulations of the wound, which remained aseptic. Dr. Leopold (*Arch. für Gynäk.*, xix. 1), in a case of nephrectomy, tied the pedicle in three, and left a triangular portion of the kidney parenchyma, in order to prevent hæmorrhage. The patient made a good recovery.

* The question of how far serious shock may be induced by tightening ligatures on parts in such intimate relation with the abdominal sympathetic centres is one of great importance, and needs further investigation. According to Mr. Barker (*Dict. of Surg.*, vol. ii. p. 49), who has taken the trouble to have the pulse watched carefully at this stage of the operation, it is not much affected to the touch, but a sphygmographic tracing taken in one case showed some irregularity during the necessary handling of the kidney, and increased arterial tension when the pedicle was ligatured. From my own experience, any alterations in the pulse are occasional only, and quite inconstant. Dragging on the pedicle is much more likely to produce shock.

recovered. The opening, in the two latter cases a small one, was at once covered by an aseptic sponge, and sutured with fine chromic gut.

Where it is certain that fluid from the kidney has entered a wound in the peritonæum, the surgeon should, after the operation is completed, make a small opening in the lower part of the linea alba and wash out the peritoneal cavity with boiled water, and place a drainage-tube in Douglas's pouch, this being regularly emptied as often as is requisite. Mr. Page of Newcastle adopted this plan in two cases, with entire success (*Lancet*, vol. i. 1893, p. 999).

The pedicle having been secured and cut through at a safe distance from the ligatures with blunt-pointed scissors, the surgeon should examine for any bleeding points,* to which the ligatures already in place will act as guides. When all bleeding is stopped,† a large drainage-tube should be inserted, with one end carried down to the very bottom of the wound and the other cut almost flush with the surface. The wound is then partially closed with silver-wire and carbolized-silk sutures, some iodoform dusted in.

* Bleeding may be due to the renal vessels breaking up into a larger number of branches than usual, or to some abnormal vessel. Dr. Lange, of New York (*Annals of Surgery*, October 1885, p. 297), in several bodies found a rather thick venous branch coming from below, behind the pelvis and ureter, and entering into a branch of the renal vein, which took origin abnormally from the renal substance on a level behind the pelvis. Dr. Lange suggests that this vessel may have been a spermatic vein, but was unable to verify this point.

† The question may arise as to what is to be done if hæmorrhage still persist after the kidney is got out, and its pedicle tied. Very few cases will occur in which ligatures cannot be applied to each bleeding point if the wound be well opened up, carefully dried, and if light be thrown down to the bottom. But when bleeding still goes on, Spencer Wells' forceps must be applied to the bleeding point and left *in situ* for two or three days, during which time they will also help to drain the wound. I have used this method twice with good results. If the forceps will not hold, careful plugging must be resorted to, strips of iodoform or sal alembroth gauze or carbolized sponges, any of those used being wrung out of carbolic acid lotion 1 in 20 (the deepest attached to silk) and systematically packed into the bottom of the wound around a large drainage-tube till the wound is thoroughly filled; an external gauze dressing is then applied, and over this a firm but elastic padding of sal alembroth wool, which is kept *in situ* by firm bandaging. Mr. Clement Lucas (*Trans. Intern. Med. Congr.*, vol. ii. p. 271) nearly lost, from secondary hæmorrhage, a case in which nephrectomy had been successfully performed for suppurating strumous pyelitis. The bleeding came on about the fifteenth day, probably from the ligatures which had been left long being dragged upon. The hæmorrhage again occurred on the sixteenth day, when an attempt was made, after opening up the wound, to slip a ligature along the old ones, and thus to re-tie the pedicle. Hæmorrhage again occurring on the seventeenth day, and the patient being in a most precarious state, the wound was tightly and forcibly plugged with two large sponges steeped in perchloride of iron, and the abdomen bound firmly round with a flannel bandage. Morphia was given subcutaneously. About a week later the removal of the sponges, by cutting away the protruding part, was commenced, and this was completed by the end of another week. No bleeding recurred after the plugging, and the patient made a good recovery.

and aseptic dressings applied. If there has been much difficulty in getting out the kidney—and in cases of old inflammation it has to be dug out by touch with very little help from sight—as in case No. 2, Table, p. 767—no sutures should be used, the wound being merely lightly plugged with iodoform gauze, wrung out of carbolic acid lotion 1 in 20.

Dr. Weir, of New York (*Ann. of Surg.*, April 1885, p. 311), during a case of nephrectomy in a young woman the subject of pyo-nephrosis, met with very severe hæmorrhage after ligature of the pedicle. This had apparently been effected with a single ligature. After removing the kidney, a gush of venous blood ensued, which was only partly arrested after repeated seizures with long pressure-forceps, but was finally controlled by stuffing the wound full of sponges and turning the patient on her back. The shock was profound, and all the measures to produce reaction were resorted to. Transfusion repeated twice to a total amount of 22 oz., gave rise at first to great improvement, but the patient died ten hours after the operation. The autopsy showed that the hæmorrhage came from a vein of considerable size, 1.5 centimetre above those secured by the ligature and forceps.

B. Nephrectomy by Abdominal Incision through the Peritonæum.

a. By Langenbüch's Incision at the Outer Edge of the Rectus.

b. By an Incision in the Linea Alba.

These two methods may be taken together. The former is the one most usually employed, as it has the following great advantages:—

1. The incision is nearer the vessels and ureter. 2. There is much less general exposure of the peritonæal cavity (Knowsley Thornton). 3. The kidney is reached through the outer or posterior layer of the meso-colon, a step which avoids (*a*) hæmorrhage and (*b*) the risk of sloughing of the colon, as it is the inner or anterior layer—that between the colon and the middle line—which contains most of the vessels to the colon, and is especially rich in veins. It is this layer which is divided in the incision through the linea alba. 4. The operation can be rendered largely extra-peritonæal by having the inner edge of the cut meso-colon and that of the parietal peritonæum held in apposition or sutured with catgut.

Both operations give good room for necessary manipulations, both afford an opportunity for examining with the hand the condition of the opposite kidney.* After both the wound can be drained, posteriorly, from the loin, but more easily after Langenbüch's incision.

* I cannot but think that this advantage of the incisions through the peritonæum has been made too much of. In Mr. Barker's words (*Dict. of Surg.*, vol. ii. p. 48), "though the hand may reach the kidney opposite to the one it is proposed to excise, its soundness or the reverse cannot be ascertained by mere palpation. Great enlargement, or, on the other hand, great reduction, in size, or complete absence, might be detected; but the organ might be tubercular, or fibroid, or contain a moderate-sized calculus, and yet the hand be unable to detect the condition." I have also referred to this matter, p. 738.

a. Langenbüch's Incision.—The abdominal wall having been cleansed, an incision is made, at least 4 inches long at first, commencing just below the ribs, in the line of the linea semilunaris on the side of the disease, the centre of the incision being usually opposite to the umbilicus. The skin, subcutaneous tissue, and the aponeuroses at the outer edge of the rectus having been divided down to the transversalis fascia, all hæmorrhage* having been carefully arrested, the transversalis fascia and peritonæum are pinched up together, punctured, and slit up on a finger used as a director, the hand is introduced, and the size of the growth and the condition of the opposite kidney investigated. In the case of a large growth, the incision will now be enlarged, and any further hæmorrhage arrested. The growth, if large, is usually now seen in part. Any presenting intestine is turned over to the opposite side, and kept out of the way with a soft, flat sponge. The outer or posterior layer of the meso-colon will now probably present itself, pushed forward by the growth, which is often bluish-white in appearance, and covered by large veins. The above-mentioned layer of the meso-colon is next torn through, either in a vertical or transverse direction, as will best avoid the vessels exposed. Any bleeding should be at once arrested by Spencer Wells' forceps and ligatures of fine chromic gut. The intestines are next packed away with a flat sponge.

A sufficient opening is next made in the outer layer of the meso-colon, and the fingers are introduced to examine into and further separate the connections of the kidney.

During all the necessary manipulations in the case of a growth, the greatest possible gentleness must be used so as not to rupture the capsule. In rapidly growing sarcomata, especially in children, the consistency may be jelly- or glue-like, and thus, if the capsule is opened, portions of the growth may readily be left behind. Again, hæmorrhage may easily follow this accident, and prove most embarrassing.† If the bleeding is of the nature of troublesome oozing it may be met by packing the cavity with iodoform gauze, the ends of which are brought out through a counter-incision in the loin. The wound in the capsule is next carefully sutured over the gauze, thus shutting off the abdominal cavity. The gauze

* The amount of this, as will be familiar to all surgeons who have opened the peritonæal cavity by this incision for intestinal obstruction, &c., varies a good deal. In the case of growth large vessels are often present in the peritonæum over the kidney.

† Thus it has even happened to Prof. Czerny, whose experience in nephrectomy is almost unrivalled, to be driven to tie the abdominal aorta. The profuse hæmorrhage met with in removing a large growth of the left kidney could only be stopped by pressure on the abdominal aorta. This vessel was accordingly tied. Death took place ten hours later. It was found that the renal artery had been torn through at its entrance into the tumour. The ligature on the aorta had been so placed that, while the blood-supply through the left was cut off, the right vessel was pervious.

may be removed in forty-eight hours (F. Page, *Lancet*, vol. ii. 1893, p. 1188). If the bleeding is from one or two points which cannot be tied, Spencer Wells' forceps may be left *in situ*, and removed in forty-eight hours.

The same precautions as to not damaging the capsule should be taken in the case of a kidney full of fluid. Where there is any risk of such fluid, or of soft growth escaping into the peritonæal sac, sponges (duly counted and secured by silk or forceps) should be carefully packed around, or the cut edges of the meso-colon and the parietal peritonæum united.

If the parts about the pedicle are free from adhesions, the vessels may be tied before the kidney is enucleated, which will render this latter step bloodless. Wherever it is possible, forceps should be placed on the vessels close to the kidney before they are divided, to save spilling of blood from the kidney, and where this contains pus, the same precaution should be taken with the ureter.

The vessels should be tied with the precautions given above (p. 756). All dragging on the pedicle should be scrupulously avoided.

The kidney being removed, the site of the operation is most carefully cleansed and dried. If troublesome oozing has occurred and is at all likely to persist, a large drainage-tube had best be passed out through the loin by pushing a short pair of dressing-forceps from the site of the kidney so that it bulges in the loin, where it is cut down upon, and used to seize the tube. Another way of draining is by a Keith's tube through the abdominal incision, sucked out regularly. Both this and lumbar drainage should be employed in complicated cases. It has been suggested that the divided edges of the meso-colon may be united with a few points of catgut suture, but this precaution does not seem to be absolutely needful, as they usually fall readily into apposition. If any septic matter is left it will be perilous.

Mr. Knowsley Thornton lays stress upon his method of treating the ureter. This tube is taken last in the enucleation of the kidney, "and, before separation, its renal end should be secured by pressure-forceps, then a ligature tied a little way from the forceps, and a sponge placed under it before it is divided. Whenever it is possible, I enucleate it for some distance from the kidney before dividing it, so that its cut end, with the sponge under it, may be at once drawn outside the abdomen; and afterwards fix it in the lower angle, or most convenient part of the abdominal incision, with a cleansed safety-pin. I regard this fixing out of the stump of the ureter as the most important detail in the operation, and in every case in which I have been obliged to cut it off deep in the wound I have had distinct evidence of suppuration and trouble around it." Mr. Thornton considers the objection that this method risks the occurrence of future intestinal obstruction an entirely fanciful one. At the worst, a ureter

so treated is only a slight ridge over a small surface of the abdominal wall, quickly disappearing by atrophy. The open end of the ureter must be kept sweet, "for sooner or later it always becomes putrid, the bladder urine also becoming offensive at the same time." Other surgeons who have treated the ureter by ligature and dropping it in, have not met with the results of suppuration and sloughing which Mr. Thornton thinks are very likely to follow on this course. The only after-trouble which I have known the ureter to give is in cases of removal of tubercular kidney. Unless this operation is performed at a very early stage, there must always be a great risk that, owing to the ureter having become involved, the mischief will spread to the bladder.

b. Nephrectomy by an Incision in the Linea Alba.—For reasons already given, p. 759, this method is not recommended, that of Langenbüch, already fully described, being preferable.

The incision in the linea alba will not materially differ from that for ovariectomy or abdominal exploration, and the same precautions are called for in removing a kidney by this method as in that through the linea semilunaris, of which the chief only need be recapitulated here—viz. :

1. Keeping the intestines well over to the opposite side by carefully applied sponges.
2. By the same means keeping the general peritonæal cavity shut off as much as possible; as pointed out already, this method has the grave objection of more readily causing infection of the peritonæum.
3. Avoiding all large vessels which are met with over the kidney, and securing these carefully with chromic gut or fine carbolized silk ligatures before dividing them.
4. Securing as full access as possible to the kidney pedicle.
5. Dealing as gently as possible with the kidney when distended with fluid, and still more when it is the seat of a soft vascular growth.
6. Separating adhesions, especially any situated posteriorly, with the utmost carefulness.
7. Avoiding all tension on the pedicle.
8. Scrupulously cleansing the site of the wound.
9. If fluids or portions of the growth have escaped into the general peritonæal sac, ensuring cleansing of this with sponges, or, perhaps better, by irrigation with a warm 2 per cent. solution of boracic acid.
10. Taking care that the cut edges of the peritonæum over the kidney are in exact apposition, either by natural adaptation or by the aid of catgut sutures.
11. Providing sufficient drainage (p. 761), if the operation has been a difficult one and the parts much disturbed, and, especially, if septic fluids have escaped into the peritonæal cavity. In this latter case irrigation with boiled water or a 2 per cent. solution of hot boracic acid must be made use of.
12. Conducting the different steps of the operation, especially the earlier ones, with as much expedition as possible, and, in addition, providing against shock by taking those precautions recommended for this purpose in any grave operation. as at p. 751.

C. Nephrectomy through the Abdominal Wall, but without opening the Peritonæum.—Having made use of

the method in one case five years ago, and being much struck by the room afforded, I may make brief mention of it.

The patient was a woman, aged fifty-four, the subject of a movable kidney on the right side, the kidney being also the seat of malignant disease. As the abdominal walls were thin, and as the kidney could easily be made to project in the anterior part of the right lumbar region, I made a longitudinal incision from the anterior superior spine up to the eighth rib. The different layers were cut through, very little hæmorrhage being met with; when the peritonæum was reached this was then stripped up out of the iliac fossa, upwards and inwards, then upwards, off the anterior surface of the kidney until its vessels came in view. No difficulty was experienced in dealing with the pedicle—first the ureter, and then the vessels. The vena cava was seen for about $1\frac{1}{2}$ inch receiving pulsation from the aorta. The patient never rallied thoroughly from the operation,* and sank about twenty-four hours after. The autopsy showed ligatures firmly tied; one of those on the renal vein had slightly puckered in the inner surface of the vena cava. A clot the size of the little finger constituted all the bleeding that had taken place. The kidney was, save for one small patch at the lower part, entirely converted into encephaloid carcinoma. Two or three of the aortic glands were enlarged; there were no other secondary deposits.

D. Combination of Lumbar and Abdominal Nephrectomy.—Dr. Hume of Newcastle made use of this method in a case of sarcoma (*Lancet*, vol. i. 1893, p. 196).

An incision about 6 inches long was first made in the linea semilunaris, and the swelling found to be in the left kidney. A lumbar incision was then made from the middle of the first cut, dividing all the structures forming the abdominal wall, including the peritonæum. The intestines were pushed to the right and protected with sponges. The peritonæum covering the kidney was then separated until the whole growth was exposed. The large cavity left was plugged with sublimate gauze dusted with iodoform, the ends of the strips being brought out by an opening in the most dependent part of the loin. The strips were removed in thirty-six hours. The patient recovered.

E. Mr. Knowsley Thornton's Combined Method.—This is given at p. 737.

a. Choice between Lumbar and Abdominal Nephrectomy.—While it is certain that all kidneys of small or moderately enlarged size can be easily removed by a lumbar incision sufficiently enlarged (p. 755), time alone will show whether I am right in my opinion that before the lumbar method is abandoned a trial should be made of such a free incision as König's (p. 755) when large kidneys have to be attacked. And this leads to the question of chief importance: How far is the danger really increased by going through the peritonæum to get at the kidney? I am strongly of opinion that, in spite of all the recent improvements in abdominal surgery and their success in preventing *peritonitis*, interference with and handling the contents of the peritonæum, save in the shortest and simplest instances, remains, on the score of *shock*, as grave a thing as ever it was. I am quite aware that, in the hands of a few operators, such as Sir S. Wells, Mr. K. Thornton, and Mr. Malcolm, removal of kidneys, even in difficult cases, through an

* I think that the thinness of the abdominal walls prolonged the operation, owing to my anxiety not to wound the peritonæum. As has been said above, the hæmorrhage was very slight, and I was careful not to pull upon the pedicle.

abdominal wound involving the peritonæum has given excellent results—results perhaps as good as, or better than, those by the lumbar method. But while allowing this, it cannot, I think, be lost sight of that the kidney is an extra-peritonæal organ, not one, like the uterus and ovary, within the peritonæal sac. It will assuredly never come about that removal of the kidney will pass, like oophorectomy and removal of the uterus or its appendages, into the hands of a few operators, however specially skilled in abdominal surgery. This being so, and the organ in question being one behind and outside the peritonæum, while each man will decide for himself and according to his special experience and line of work, the majority of surgeons will, I think, prefer to make their attacks from behind whenever this is possible. This question is also dealt with above (p. 737).

LUMBAR NEPHRECTOMY—ADVANTAGES :—1. The peritonæum, save in case of exceptional difficulty, is not opened or contaminated. 2. Efficient drainage is easily provided. 3. The structures interfered with are much less important. 4. As pointed out by Mr. Greig Smith, “in the case of its being unwise, as in abscess, or in tumour affecting the surrounding tissues, to proceed to removal, it is less serious to the patient.” If the kidney is firmly matted down, as in the cases given at p. 754, such dense posterior adhesions are most readily dealt with by the lumbar method. 6. The lumbar incision, if converted into a T-shaped one, or prolonged forwards by König’s method, will give sufficient room for meeting most of the conditions which call for nephrectomy. Thus modified, it will suffice for new growths in their early stages. If these are operated on later, one of the abdominal methods will probably have to be made use of.

LUMBAR NEPHRECTOMY — DISADVANTAGES :—1. It is usually thought that too little room is given by this method for the removal of large kidneys. It has already been shown (p. 755) how extensively this incision can be enlarged. It is doubtful, therefore, if this objection holds good for any cases, even those of unusually long-chested patients, or those with spinal deformity. 2. In a fat subject the organ may be difficult to reach, even when well pushed up from the front. 3. The pedicle is less easily reached,* and thus in cases of difficulty, bleeding at a very important stage of the operation is less easily dealt with. 4. If the kidney be very adherent, important structures—*c.g.*, the peritonæum (pp. 730, 757) and colon—may be opened into, unless great care is taken. 5. The condition of the opposite kidney cannot be examined into. Possible fallacies here have been pointed out, pp. 738, 759.

NEPHRECTOMY BY ABDOMINAL INCISIONS IN THE LINEA ALBA, OR AT THE EDGE OF THE RECTUS, THE PERITONÆAL CAVITY BEING OPENED—ADVANTAGES :—1. Additional room in case of large kidneys. 2. More easy access to the pedicle. 3. The possibility of examining the condition of the other kidney. It has already

* This objection and the next can be met by a very free incision (p. 755).

been pointed out (pp. 738, 759) that this advantage is probably overrated.

NEPHRECTOMY BY ABDOMINAL INCISIONS THROUGH THE PERITONÆUM—DISADVANTAGES:—1. The peritonæal sac is opened. 2. The same sac may be seriously contaminated if a kidney containing septic matter, or one largely converted into soft growth, is ruptured during the needful manipulations. 3. The intestines may be difficult to deal with, and may, by crowding into the field of operation and the incision in the abdominal wall, prove most embarrassing. 4. The handling and interference with the contents of the peritonæum may cause considerable shock. 5. The vitality of the colon may, by interference with its blood-supply, be endangered. 6. It is more difficult, by this method, to deal with any dense adhesions which may exist behind the kidney. 7. If bleeding follow the operation reopening an abdominal wound, finding the bleeding points and securing them, or plugging the wound will be attended by more shock than the adoption of the same course by the lumbar method. A case supporting this view is candidly reported by Mr. Page of Newcastle (*Lancet*, vol. ii. 1893, p. 1187). 8. Efficient drainage is less easily provided in cases of any contamination of the peritonæal cavity, or of oozing after the kidney is got out. 9. The after-complication of a ventral hernia is much more probable by this method, though it must be allowed that the free lumbar incision already alluded to may be followed by the same result.

Causes of Death after Nephrectomy.—1. Shock.—This may be induced by hæmorrhage, much traction on the pedicle, and thus, probably, interference with the solar plexus, injury to the colon, and, where the peritonæal cavity is opened, by much disturbance of its contents. 2. Hæmorrhage.—This is especially to be dreaded where the pedicle is deep and difficult to command; where there are aberrant renal vessels; where these vessels are enlarged and perhaps softened; where, owing to too much tension on the pedicle, a vessel retracts from within its loop of ligature; where the kidney capsule and tissue are broken into. In the intra-peritonæal method there is the additional danger of enlarged veins within the meso-colon. Secondary hæmorrhage has been alluded to above, pp. 734, 758. 3. Uræmia and Anuria.—These are only likely to occur when it has been impossible to form a correct estimate of the condition of the opposite kidney, or where, to give a patient a chance, the surgeon operates in what he knows to be a doubtful case. Where there is reason to believe that the suppression of urine may be due to a calculus in the opposite kidney, this should at once be cut down upon in the hope of finding a calculus that can be removed. Mr. Lucas's brilliant example of what nephrolithotomy may do when such peril sets in at a later date has been referred to at p. 740. 4. Peritonitis.—This, if septic, is due either to mischief introduced in the operation or from the kidney. While it is certainly more likely to follow the intra-peritonæal operation, it may occur after that through the loin, especially when much difficulty is

met with here, owing to numerous adhesions, or to working in a wound of insufficient size.* 5. Septic trouble—Cellulitis—Erysipelas—Pyæmia.—These are especially likely when the kidney contains septic matter, when the soft parts are much bruised, or when many fingers enter the wound. Other, rarer, causes of death are—6. Pulmonary embolism. 7. Empyema.—This may be brought about by an extension of septic cellulitis, or by removing, during the operation, a portion of rib in order to get more room—a step the danger of which cannot be too strongly enforced, p. 724. An anatomical predisposition favouring the passage of inflammation from the kidney to the pleura has been pointed out by Dr. Lange, of New York. This authority on renal surgery found, in one subject, an enormous gap in the diaphragm, the muscle fibres being absent from the ligamentum arcuatum internum as far as the outermost part of the eleventh rib. Between these two points the fibres of the diaphragm communicated in a high arch, bounding an area in which the fatty tissue about the kidney was in direct contact with the pleura. 8. Intestinal obstruction.—This occurred fatally in one of Mr. Thornton's cases. He thought it was brought about by his suturing the two edges of the peritonæum over the kidney together, and thus producing kinking of the large intestine.

Partial Nephrectomy.—This step has been performed by, amongst others, Tuffier of Paris and Kummell of Hamburg. The former bases his recommendation on experiments on animals, by which he proved that it was possible to remove successfully a large amount of the renal tissue. A fallacy is obvious. The surgeon was dealing here with healthy renal tissue. Part of the kidney has been removed in the treatment of cysts, growths, &c. It is stated that the hæmorrhage can always be arrested by pressure, sutures or the use of iodoform gauze tampons.

Kummell (*Centr. f. Chir.*, vol. viii. 1890) used it successfully in two cases, and states that very little soakage took place through the wound. The only case for which this operation recommends itself to me is where the kidney has been lacerated by injury. Here the organ will very likely be healthy, and removal of an almost detached part may be sufficient to arrest the hæmorrhage. Mr. Keetley has recorded a case of this kind (*Lancet*, vol. i. 1890, p. 134).

A young man had been crushed by a waggon-wheel. There was laceration. Five or six hours after the accident he showed signs of serious recurrent hæmorrhage. Through an incision a mass of blood clot was scooped out, also the separated lower end of the kidney, a deep bleeding point being compressed with sponges which were removed in twelve hours. Convalescence was rapid. No urinary fistula or hydronephrosis resulted.

* During a nephrectomy for pyonephrosis the peritonæum was injured owing to the adhesions of the renal capsule. As it was thought certain that some septic fluid had escaped into the peritonæal cavity, this was opened by a small incision above the pubes after the lumbar wound had been closed. Some ounces of bloody fluid escaped, the cavity was washed out, and a drainage-tube placed in Douglas's pouch. The patient recovered. (F. Page, *Lancet*, vol. i. 1893, p. 999.)

No.	By whom sent.	Sex.	Age.	Disease.	Result.
1.	Dr. Moxon.	F.	45	Carcinoma.	Death, about thirty hours after, from prolonged shock. This kidney, though greatly enlarged, was got out through a very free lumbar incision by tilting its long axis into that of the wound. I see now that I took up too much time in tying every small vessel as I went along. Two of the glands on the vena cava were carcinomatous.
2.	Mr. E. O. Day.	M.	27	Very long standing pyelitis; drainage.	Recovery. This patient had had cystitis nearly all his life. Eight years before, he had been cut for vesical calculus in Nottingham. He was sent to me in a state of septicæmia, due to a most foul pyelitis. This was drained, but a sinus persisted, and fourteen months later I removed the kidney. This was very small, and so universally and firmly adherent that it had to be literally dug out by the finger. The man had constant hiccough for a fortnight, possibly due to some injury to the phrenic or the diaphragm.
3.	Dr. F. Taylor.	F.	42	Tubercular pyelitis.	Recovery. She is alive eight and a half years later, with no irritability of the bladder, and passing no pus.
4.	Dr. Phillips, Bedford.	M.	—	Tubercular pyelitis.	Recovery, eleven years ago. He completed his terms at Cambridge and took curacies. Fourteen months after the operation he began to show signs of tubercular mischief in the prostate and vesiculæ seminales. A little later he, most unwisely, married. Two children were born, each quickly dying. When last heard of, nine years after the operation, he was holding a chaplaincy abroad; a sinus had apparently formed in connection with the stump of the ureter.
5.	Dr. Philipps, Faversham.	F.	3	Sarcoma.	Recovery from operation. Death two months later. The renal vein was found thrombosed with growth at the operation.
6.	Dr. Perry.	M.	2½	Cystic disease, ? congenital.	Recovery.
7.	Dr. G. Newton Pitt.	M.	30	Calculus pyelitis.	A year before, I had performed nephro-lithotomy and removed eight stones. A most fetid sinus persisted, kept up by a phosphatic stone, which I had left behind, in the upper end of the kidney.
8.	Dr. F. Taylor.	F.	18	Tubercular pyelitis.	Recovery. The kidney had been explored and drained six weeks before.
9.	Dr. J. B. Howell, Wandsworth.	F.	23	Pyonephrosis; no cause was made out.	Recovery. The kidney had been explored and drained five months before.
10.	Dr. B. Scott, of Bournemouth.	F.	34	Hydronephrosis.	Recovery. In this case there had been colicky pains and frequent micturition, simulating calculus, for three and a half years. A swelling had been noticed for a few months. This was first drained, and, three months later, the kidney was removed.

Lumbar Nephrectomies.—(continued.)

No.	By whom sent.	Sex.	Age.	Disease.	Result.
11.	Dr. G. Newton Pitt.	F.	26	Tubercular pyelitis.	Recovery. T. bacilli in urine. Kidney when removed in an advanced stage of caseation and excavation. Two sinuses remained here which closed firmly after being scraped out. Owing to presence of vesical pain and inability to hold water (AgNO_3 3ij-5i) was applied to mucous membrane of the bladder. As a result the patient was able to hold her water for three hours. It is to be feared, however, that the disease in the kidney had lasted too long, and that in the bladder was too advanced to admit of a permanent cure. The disappearance of hectic and the gain of flesh were however very marked after the nephrectomy.
12.	Dr. F. Taylor.	F.	22	Tubercular pyelitis. Tubercle bacilli found in the urine. Tubercular pyelitis.	Recovery. Previous drainage. Removal of kidney a month later. Two and a half years later patient reports herself as "in the best of health."
13.	Dr. Luscombe of Twickenham.	F.	34	Tubercular pyelitis.	Recovery. Drainage of the kidney and, at the same time, removal of a calculus from the ureter one and a half inches below the pelvis. Removal of kidney three weeks later. Severe parotitis three weeks afterwards, requiring incisions. I saw this patient three years afterwards. She was well and strong, and had borne a healthy infant.
14.	Dr. T. Taylor.	M.	18	Hydronephrosis.	Recovery. Frequent pain in left side, alternating with vomiting. Kidney dilated into a very large sac, extending up under ribs. Removal without previous drainage. Small part of the cyst left behind for security of ligatures. The hydronephrosis was probably due to an abnormal arrangement of the renal vessels, and thus pressure on the ureter.
15.	Dr. Sandoe of Broadclyst.	M.	35	Tubercular pyelitis.	Recovery from the operation. Patient had had one forearm amputated for "strumous disease of wrist." Admitted for perinephritic abscess. This was drained. A month later the kidney was removed. The presence of tubercle bacilli continued in the urine. The wound was not quite healed when the patient left, and he died from exhaustion and failure of the other kidney two months after leaving the hospital.
16.	Dr. Blood of Bickenhead and Dr. Goodhart.	F.	31	Tubercular Pyelitis. No bacilli found.* A sister died of pulmonary phthisis.	Recovery. The kidney showed most extensive caseation and early vomica. I have seen this patient recently, nearly five years after the operation, and her health is excellent.
17.	Dr. Uhthoff of Brighton and Dr. Goodhart.	M.	14	Tubercular pyelitis, and probably early cystitis.	Recovery. The kidney here was greatly enlarged. Fortunately it was not very fixed. It was got out through a lumbar incision much prolonged, and T-shaped. About six months later I had to scrape out two sinuses, probably connected with the stump of the ureter, which was in a state of advanced disease. About three years after the nephrectomy castration was required for tubercular disease of one testicle, and a little later he was placed under my care again for a sinus connected with the castration wound. The cut end of the vas was found to be tubercular and was freely removed. All has been soundly healed for nine months, but the outlook is very gloomy.

No.	By whom sent.	Sex.	Age.	Disease.	Result.
18.	Dr. Galabin.	F.	38	Carcinoma.	Recovery from operation. Here there was some question whether the large kidney would come out through a lumbar incision. This was effected by a very free incision and tilting the long axis of the kidney into that of the wound. The patient died five months afterwards of secondary deposits.
19.	Dr. Halstead of Iamsgate.	M.	57	Hydronephrosis. No previous drainage.	Recovery. Here a sinus persisted for over a year after the nephrectomy, due to a piece of silk. I have seen this patient lately, four years after the operation, in excellent health.
20.	Accident, Guy's Hospital.	M.	13	Laceration of kidney. Other injuries.	Death. This patient was in a most grave condition when I was asked to see him. Forty-eight hours before a van-wheel had passed over his abdomen and chest. Hæmaturia had been constant, profuse, and accompanied with clots. The region of the right kidney was occupied by a very tender swelling. The patient was delirious, due, I thought, to absorption from the breaking down clots, and the pulse scarcely perceptible owing to the hæmaturia. To give him a chance I performed nephrectomy, which was as simple as possible. The kidney was found torn in half, one part being connected with the ureter, the other with the vessels. Transfusion was performed, but nephrectomy came too late, and the patient sank a few hours later. The autopsy showed bruising of the liver, some blood in the peritoneal sac, which was uninjured, and much effused around the cæcum and ascending colon.
21.	Dr. F. Taylor.	F.	35	Calculus pyelitis. Bilateral.	Death. At the time of the nephrectomy, one large irregular calculus and several small faceted ones were removed from the right kidney. As this was much enlarged, its cortex indurated, pale, and atrophied, it was removed. Three days later it is noted that thirty-six ounces of urine were passed in the previous twenty-four hours. This quantity gradually lessened, sickness gradually increased, and the patient sank fifteen days after the operation. The autopsy showed that the left kidney was also the seat of hydronephrosis, and the ureter here occupied by a calculus.
22.	Royal Hospital for Children and Women.	F.	21	Tubercular pyelitis.	Death. Eight years before I had excised the right knee-joint of this patient. The right kidney was greatly enlarged and much thickened, there being but little pus in proportion to the advanced caseation. It was extremely adherent, especially above, under the diaphragm. Towards the close of the operation, as I was clearing the pedicle, which was much overlapped by the enlarged kidney, I wounded the vena cava. The opening was promptly clamped and ligatures placed above and below. The operation was most difficult throughout, and accompanied by much shock. Transfusion was resorted to, but the patient sank three hours later.
23.	Dr. Brogden of Ipswich.	F.	23	Pyonephrosis.	Recovery. Pain had existed in the right kidney for eight years. Nephrorrhaphy and, later on, nephro-lithotomy (three oxalate calculi had been removed), had been performed by Dr. Brogden, with great relief for some years. The kidney was much dilated, with a very wasted cortex. Three oxalate calculi were found in the upper and two in the lower end, all very minute and in dilated calyces.

The above list shows twenty-three cases with four* deaths. Tubercular cases, where the mischief is advanced and the adhesions extensive, as in Case 22; malignant growths; and cases of calculous pyelitis where both kidneys are affected, though one only at the time of operation may contain stones, will always keep up the mortality of nephrectomy. Mr. H. Morris (*Brit. Med. Journ.*, vol. i. 1893, p. 1) gives the following statistics of his cases: "(a) In five cases of nephrectomy for solid tumours there were two deaths; (b) in six cases of hydronephrosis there were no deaths from the operation; (c) in seven cases for calculous affections two deaths occurred; (d) in five cases for tuberculous disease there were three deaths. Thus, we have seven deaths out of twenty-three cases."

NEPHRORRAPHY.

It is well known that nephrorraphy has not always been followed by the relief expected. This, I think is due to one or more of the following causes:

1. The operation has been performed in unsuitable cases. (A.) Cases where the mobility of the kidney is only, in reality, a small part of the trouble. A well-marked instance of this group would be those cases where mobility of the kidney co-exists with a markedly neurotic tendency, a group in which, were it not for the above tendency, the mobility of the kidney would be little complained of; a group in which operation has been resorted to much too often, thus bringing much discredit upon it; a group, finally, in which nephrorraphy is rarely to be resorted to, and then only with the greatest caution.† In dyspeptic, neurotic women approaching the menopause the operation should be avoided altogether.

In the neurotic tendency lies one of the chief difficulties with regard to making a decision on the question of operation. The frequency with which a highly nervous temperament is present suggests the obvious question, Would these symptoms have arisen were it not for the neurotic tendency? Any honest medical man would answer that in the majority they would not. In a certain number the mobility of the kidney determines the region and distribution of the neurotic trouble, in a very few it originates and causes the neurotic tendency.‡ Again, where long-standing dys-

* I have included No. 20, as I performed the nephrectomy. The case was, however, admitted under the care of another surgeon, and I was only called to it at the very end. On the other hand, Case 15 ought, perhaps, to be accounted a fatal case of nephrectomy.

† In an interesting paper by Dr. Drummond (*loc. infra cit.*), thirty cases of movable kidney are given, two of which were treated by nephrorraphy. Both relapsed. In a third case, the details of which were supplied to Dr. Drummond, "excision of the movable kidney was practised without any relief."

‡ As in the rare cases where a man, previously active and healthy, has his life spoilt and becomes hypochondriacal after one kidney has become movable.

pepsia and constipation, or uterine and ovarian trouble co-exist with a movable kidney it will be useless to perform nephrorraphy, unless the other ailments can be corrected—a matter of no little doubt and difficulty in some of those patients in whom we meet with this disorder. (B.) In a certain proportion of movable kidneys—and this, perhaps, a larger one than is usually allowed—organic disease coexists as well. I have met with three such cases. In one (Case 1, table, p. 767) the kidney was the site of carcinoma; in a second (Case 8, *loc. supra cit.*), early tubercular disease must have been present. About two months after the nephrorraphy, pain having returned, further examination showed that the urine, which had before been found normal, contained pus. At a second operation two early foci of tubercular suppuration* were found and the kidney was removed. Six years later the patient was alive and well. The third case was one associated with hydronephrosis. At this time, when performing nephrorraphy, I was passing my sutures through the tissue of the kidney itself, a method which I now consider quite unreliable, and I am doubtful if the relief given in this case of hydronephrosis was permanent. The question of nephrorraphy in hydronephrosis is referred to below.

2. Another frequent cause of nephrorraphy failing to give permanent relief is the way in which the operation is performed. Too often the peri-renal fatty tissue has been thoroughly pulled out, some of it removed, and its edges sutured to the lips of the wound. Frequently the kidney is already movable within this capsule and no good results, and where no such mobility has existed, the loose fatty tissue, however carefully pulled out, tightened and stitched, gradually stretches and ceases to fix the organ. In other cases the operator tries to pass his sutures so as to take up the capsule of the kidney without regarding more than the surface of the cortex. Such a hold is insufficient. In other cases—and this is very frequent—the kidney tissue itself is deeply traversed by the needle. Now, the friability of the kidney is well known. Every operator who has passed sutures in this way is familiar with their tendency to cut through before or just as they are finally tightened and tied. So soft is the tissue of the kidney, especially when injured and inflamed—as around a suture—that I believe that even when silk sutures thus passed have been left *in situ*, their cutting through is only a matter of time.† When catgut, however stout, has been em-

* My silk sutures, with which the kidney had been fixed, were found *in situ*, but as the collections of pus were on the inner aspect of the kidney, I do not think they dated to the stitching, in which the kidney substance had been boldly taken up. The early appearance of pus after the nephrorraphy is, however, suspicious, and it is quite possible that in delicate patients the injury inflicted by suturing might be the starting-point of tubercular disease of the kidney.

† Mr. Gilford, of Reading, a very earnest worker, thinks that the following method meets the above objection. Two stout silk sutures, having been passed deeply through the substance of the kidney, "are brought out between

ployed the result is still worse. Like silk it is very liable to cut its way through the easily lacerable kidney tissue as it is tied, if it does not do so then its softening takes place so quickly in the vascular kidney tissue that any permanent anchoring by the blending of this material with other tissues is impossible.* Moreover, there is another danger, not altogether a fanciful one, which may follow on deeply puncturing the kidney. A German surgeon, Barth, has seen a necrotic centre caused in the kidney owing to the occlusion of one of the arterial centres by the anchoring suture. A similar condition has been noted as the result of puncture. One of the large arteries was obstructed, hæmorrhagic infarction took place, and ultimately necrosis. (M'Ardle, *Brit. Med. Journ.*, vol. i. 1894, p. 526). A third step that has been advised, scarifying of the surface of the kidney and scraping the adjacent muscles and fasciæ, does not commend themselves to me as satisfactory at the time or likely to be of permanent utility later.

To speak of the indications more exactly. Where an otherwise healthy kidney is very movable, especially where this dates in sensible people to an injury, where the surgeon is in doubt as to an operation, he should try and satisfy himself that other treatment, including a sufficient trial of a well-fitting belt has failed, that the pain, whether constant or paroxysmal, is *bonâ fide*, and that it really cripples and spoils the patient's life. Thus, conditions of movable kidney which call for operation are: When it is accompanied by undoubted vomiting, or when, on the patient's stooping, the viscus comes down so far as to be jammed between the ribs and the crista ili. Constipation and dyspepsia will of course have been treated. tight lacing given up, and a trial made of a well-fitting belt, or a corset coming low down in front and so fitted as to gather up the lower part of the abdomen and its contents.

Another strong indication for nephrorrhaphy is early hydro-nephrosis. Here the operation is resorted to not only to save the patient from the pain caused by the movable kidney, but to "prevent the organ from bringing about its own destruction" (Lucas). Mr. Lucas (*Brit. Med. Journ.*, vol. ii. 1891, p. 1344) relates four cases in which mobility of the kidney, displacing of the organ on to its transverse axis, may cause bending of the ureter,† and thus

the lips of the incision and passed round a piece of glass rod placed across the wound. In this way a firm grasp is taken of the kidney, the sutures cannot break through its fragile substance . . . and are removed, partly on the tenth, partly on the fourteenth day." I doubt if such cures are permanent.

* Dr. Newman drew attention to this fact several years ago (*Lects. on the Surg. Dis. of the Kidney*, p. 69): "The sutures passed into the kidney became destroyed more rapidly than elsewhere; the living renal tissue seems to have an unusual power of absorption."

† This same displacement of the kidney which occludes for a time the ureter, will also, by twisting the pedicle, affect its vessels also. As Mr. Lucas points out, the vein will suffer more from pressure than the artery, thus causing turgescence of the organ generally as well as distension of its pelvis. Thus are brought about

distension of the pelvis with urine. Two of the cases were treated by nephrorraphy, and when last seen remained cured. One of the cases, in which the hydronephrosis was undoubtedly due to the displacement, seemed to show that the destruction of the kidney may occasionally go on without any severe attacks of pain.

Operations for Movable Kidney.—These are:

A. Nephrorraphy.

B. Nephrectomy.

A. Operation of Nephrorraphy.—The kidney is first exposed by the incision* and the steps already fully given (p. 724). The lumbar fascia being opened, the wound is widely dilated by the use of retractors, which gather up the whole thickness of the wound down to the renal capsule, and by an assistant pulling up the ribs if need be. During the rest of the operation another assistant with steady pressure on the right spot forces the kidney into the wound and keeps it there.

The surgeon next examines the kidney as to whether it is sound, enlarged, &c.

Several questions now arise as to the sutures. (1) What is the best material? (2) What tissues are to be taken up?

The answer to each of these questions is in my opinion a simple one. (1) Silk which is easily obtained and readily sterilised with a little care will be quite efficient. It should not be of the plaited kind (footnote, p. 446); it should be of medium size and carefully prepared. Buried as it is deeply the use of silk here is not open to the objections to which I have alluded in the account of Radical Cure of Hernia (p. 654). Kangaroo-tail tendon is another excellent material.

(2) In answer to this question I am strongly of opinion that to ensure a permanent cure in nephrorraphy, the sutures should take hold of the proper capsule of the kidney itself, after this has been careful peeled off in two flaps. I have tried other methods, *e.g.*, inserting them through the substance of the kidney itself, either fastening them to each side of the wound and dropping them in, or passing them from one lip of the wound through the kidney and finally through the other lip of the wound. The longer I watched my cases the less reason had I to be satisfied, though the earlier results had been excellent.

I have used the following method in nine cases, one of which, a patient of Dr. Brogden's of Ipswich, was operated on seven years ago. She remains well, having married and had a child since the operation. Of the others, all save two have been operated on over 1½ years; of these seven I know of six, and in these the

* the nausea, pain, vomiting, &c., which have been described as strangulation or acute dislocation of the kidney. (Bruce Clarke, *Trans. Med. Chir. Soc.*, vol. lxxvi. p. 263; *Brit. Med. Journ.*, vol. i. 1895, p. 575).

* In a fat patient, or where there is much difficulty in finding the kidney, a T-shaped incision may be needed. Here the vertical part should be closed before the sutures are passed.

kidney remains fixed. The last, the ninth case, is too recent to be of much value, this lady, an American and M.D. of Boston, having been operated on in August and October of last year. This is the only double nephrorraphy which I have performed.

Operation.—The kidney is first thoroughly exposed by the steps given at p. 724, an assistant keeping the organ well pushed back into the loin while the surgeon cuts down on it. I may here say that in some of these cases of very movable kidney the tissues around are so loose from the dragging and shifting to and fro of the kidney that they wrap round the organ very closely, and thus it is easy to injure the peritonæum. Thus, in the last of the patients mentioned above the right kidney was mobile through an extremely wide range, and so loose that when lying on her left side the patient could make it project as a convex lump in the right iliac fossa. When I was operating on this side I found the kidney easily reached, but not easy to define, owing to the extreme looseness of the folds of the perinephritic tissue and peritonæum.* This latter structure I opened in two places, the thin edge of the liver appearing at one, and some omentum in the other. The first opening was clamped and tied up with a catgut ligature, the second closed with a continuous suture of the same. Strict aseptic precautions were taken and not the slightest ill result followed.

The kidney itself having been exposed it is gently withdrawn through the wound, surrounded with aseptic sponges while an incision is made with a very light hand all along the convex border from end to end. Unless the utmost gentleness is taken in the last step the tissue of the organ itself will certainly be incised, causing free oozing. With the handle of a scalpel or a blunt dissector, a flap of capsule is then deliberately but gently stripped off the kidney up to a point about halfway along its lateral surfaces, so as to raise a sufficient flap for the sutures to find a holding in. The flaps having been raised they are sutured with medium-sized sterilised silk to the aponeurotic and subcutaneous edges of the wound. To get a firm and permanent holding each suture should take up plenty of capsule on the one side and a sufficient grip of the lumbar fascia on the other. I generally use upwards of twenty sutures, perhaps twelve in one flap and eight in the other. One word of caution should be added. This method of anchoring is so efficient that.

* This was not a mesonephron, an exceedingly rare condition. I find that Dr. Drummond of Newcastle described a similar condition several years ago ("Clinical aspects of Movable Kidney," *Lancet*, vol. i. 1890, p. 121): "In almost every instance in which the kidney has been found to be freely movable the other abdominal organs have been correspondingly loose in their attachments—the spleen, liver, cæcum, stomach, &c. More than once a distinct mesonephron was present, but much more often the peritonæal covering was simply loose, so that the organ could be easily placed in various novel positions. At times the kidney had dragged the relaxed peritonæum so far from the abdominal wall as to bring into close conjunction the upper and lower layers, so as to form a false mesonephron."

unless care is taken, it is possible to fix the kidney which has been drawn out actually in, and not beneath, the lips of the wound. After one row of sutures, say the upper, has been inserted, tied and cut short, and the second merely inserted, care should be taken gently to push the kidney into its proper place in the loin, just under the wound; the lower sutures are then also tied, cut short, and dropped in. Any oozing met with after stripping off the flaps of capsule will yield to firm sponge-pressure kept up by an assistant while the surgeon is putting in his sutures. It is well also to keep a sponge in the iliac fossa to be removed before the last sutures are tightened. If when all bleeding is arrested the wound is very carefully dried out, and dusted with Jeyes' powder, no drainage tube will be required. In closing the wound I adjust the lumbar fascia with buried sutures of chromic gut, and the skin with salmon gut. I recommend this method most strongly: it is both easy and efficient, and sufficient time has now elapsed in several of my cases for me to be able to say that no injury is inflicted on the kidney by the partial removal of its capsule. So convinced am I of the superiority of this method that I shall not occupy my space or my readers' time in describing any other.

CHAPTER V.

OPERATIONS ON THE INTESTINES.

ACUTE* **INTESTINAL OBSTRUCTION.**—**APPENDICITIS.**
—**PERFORATING ULCER OF STOMACH.**—**OF DUODENUM.**—**OF INTESTINE AFTER TYPHOID FEVER.**
—**SUPPURATIVE PERITONITIS.**—**TUBERCULAR PERITONITIS.**—**ENTEROSTOMY.**—**FORMATION OF ARTIFICIAL ANUS.**—**SUTURE OF INTESTINE.**—**RESECTION OF INTESTINE.**—**ENTERECTOMY.**—**COLECTOMY.**—**INTESTINAL ANASTOMOSIS AND SHORT CIRCUITING.**—**ENTEROPLASTY.**—**CLOSURE OF ARTIFICIAL ANUS AND FÆCAL FISTULA.**

ACUTE INTESTINAL OBSTRUCTION.

State of the Question of Operation at the Present Day.

Here there are three distinct camps of practice :—*a.* The sanguine, who would operate in every case and who maintain that operation, if only performed early, will be successful. While I admit that in the majority of these cases Medicine will be futile, while I most readily allow that an exploratory operation in skilled hands is always justifiable, if the patient's condition admits of it, and if the surgeon knows how far he should go, I maintain that it is a dangerous mistake to group all cases of intestinal obstruction together, as comparable from the operative point of view ; some cases are simple, some most difficult, nay more, in some the mischief, though acute, has been so long in existence, that they have reached a practically fatal condition before Surgery has a chance of interfering. *b.* The expectant, because hopeful of a "spontaneous cure." We want light on the nature of these spontaneous cure cases. My own belief is that, if they are watched, it will be found that many are not permanently cured ; that many are cases of incarceration, not strangulation—*cr.* hernia ; and that others are cases of malignant disease in an early stage. *c.* The expectant, because hopeless of these cases from the very first. I think all candid surgeons must admit that the results of the treatment of acute intestinal obstruction are most unsatisfactory, and the more thoughtful ones must have asked why has so little advance been made here, compared with the other results of Modern Surgery. The explanation is three-fold. *a.* **Difficulty of diagnosis.** (1) Is it acute intestinal obstruction :

* The chronic variety has been already dealt with (p. 688). See also Enterostomy, p. 821.

This difficulty is, I think, exaggerated. Many conditions, I admit, simulate acute intestinal obstruction, *e.g.*, typhlitis and appendicitis, peritonitis from different causes, thrombosis of the mesenteric veins, enteritis, &c., but I hold that in some of these an operation may be beneficial, while as to the others it would be better that an exploratory operation, as long as this is done by skilled hands, took place needlessly than that a remediable condition was left untouched. The difficulty of diagnosis is usually of a different kind. It is too often an undoubted case of intestinal obstruction, but the difficulty is to say of what nature it is. Is it one remediable by operation or no? (*vide infra*). This difficulty of diagnosis, often of paramount importance, is often to be cleared up by operation alone. *b. The peculiar vitality of the parts concerned.* This is a constant factor. I allude, of course, to the readiness with which the intestines lead themselves to distension, to paralysis, and, from the facility with which their blood supply is cut off, to sloughing. We may compare this with Brain Surgery. Here, in another peculiarly vital part, the advances of Modern Surgery have again not been as brilliant as elsewhere. *c. Faulty classification.* The large mortality of operations in acute intestinal obstruction largely arises from grouping all acute cases together as equally fit for operation, and from submitting them, too often, to prolonged manipulation.

And even when such a group as the cases favourable for operation is taken, *e.g.*, bands, all are not to be grouped together as equally favourable. To take single bands, for instance, the most easily dealt with of all cases of acute intestinal obstruction. Such must be divided into (1) Those which are easily accessible; (2) Those which are only found with difficulty; (3) Those which are so placed as not to be found at all, *e.g.*, in the pelvis.

(1) *The usual classification is Acute and Chronic.* (2) *A better is, Acute, Chronic, and Acute on Chronic.* This is a very important point. Chronic obstruction may put in an acute appearance. This late-coming acuteness may be mistaken for an early acuteness, and the fact that the mischief is probably in the large intestine may thus be overlooked. Malignant disease of the large intestine may be suddenly revealed by symptoms of acute obstruction, thus being comparable with retention of urine, the first evidence of a long-standing stricture. Such cases are most misleading if the history is imperfect or withheld. (3) *From the operative point of view the best classification is (a) Those cases which give some hope; (b) Those which give little or none. Vide infra.*

Common Fallacies and Mistakes.

Chief amongst these are: (1) **The comparison of abdominal section for acute intestinal obstruction with ovariectomy or herniotomy, and the expectation that its results will equally improve.** This comparison is most misleading and dangerous. To prove this briefly—there is an immensity of difference between the two cases in (a) The exactness of diagnosis before the surgeon interferes; (b) The state and fitness of the patient to bear a severe operation; (c) The conditions met with, usually well-known in the one case, are most obscure and often perplexing in the other; (d) The amount of interference needed with vital parts. (2) **Expectation that a large proportion of success will follow after operations for acute intestinal obstruction, if only performed early.** While holding that it is always justifiable to explore in these cases and that by this alone can the diagnosis be cleared up, I fear that there will always be cases hopeless, almost from the first, or so early as to render the prolonged operation, which is often needful, futile. At least

three classes of cases are met with: *a. Those favourable for operation, viz., (a) some bands; (b) some internal herniæ; (c) some cases of gallstone; (d) some cases of intussusception. b. Those cases which give out little hope, or which are hopeless, viz. (1) cases of complicated bands with snaring or matting of the small intestine (2) a severe volvulus. c. Cases technically cured by operation, but seen too late.*

With regard to this second fallacy the two following points should be prominently put forward: (1) That what I will call **man's vital capacity**, I mean his capacity for bearing severe operations, is finite and will remain so, however infinite the advances of Modern Surgery may prove to be; (2) **The peculiar vitality of the parts now submitted to operation** (*vide supra*.) (3) **The mistake of expecting that if all cases are submitted to operation our search will always be successful, and the cause both found and removed.** Thus we have the fact that (*a*) bands may be multiple, *e.g.*, one being found and dealt with in the abdomen, while another exists, unfound, in the pelvis. (*b*) The tight gripping of the hands by the strongly developed abdominal wall, not here stretched and thinned by a large ovarian cyst. (*c*) The crowding around of distended coils, tending to escape every moment. (*d*) The risk of fatally disturbing parts already damaged. (*e*) The condition of the patient, the anxiety of the anæsthetist, &c. How frequently operative steps will fail—and it is only honest to admit this and to be prepared for it, though I repeat my opinion that these cases should always be explored when the stage is not advanced and the exploring hands skilful—is shown by the experience of Madelung, well known as an authority in this matter. In several cases, where the seat of obstruction could not be defined during life, this surgeon requested the pathologist at the autopsy to localise the obstruction by passing his hand through an incision, allowing him from ten to twenty minutes for the exploration; in every instance he failed to find the obstruction within the given time. (Senn.)

Question of Operation.

Two points arise here: *a. Shall I operate? b. If so, how far shall I go?* *a. Shall I operate?* The decision here lies between medical treatment, in the very great majority only palliative, and operation which, while nearly always justifiable under the conditions which I have mentioned, will only in a limited number of cases achieve brilliant successes, failing as it too often will to save life, in the majority, owing often to the complicated nature of the cause of the obstruction, the peculiar vitality of the parts which have to be handled, and the readiness with which these pass into a condition beyond recovery. (2) *The operator* should not be a man who will only operate at the most upon one or two cases. (3) *The condition of the patient* should be such as will justify surgical interference. The surgeon should firmly decline to interfere in all "too late" cases, especially when he is only called in towards the end (without any chance of learning anything about the case beforehand) so, that, medicine having failed, something may be done. (*b*) **How far shall I go?** The operation must be according to the state of the patient. These cases of acute intestinal obstruction are not to be grouped together as all equally fit for operation, or as all certain to be relieved by operation as long as this is undertaken early. In some the condition of the patient is good, the abdomen is undistended and a prolonged search may be made. In others a precisely opposite condition is present, any prolonged exploration is out of the question, and all that can be done, if the cause is not found at once, is to open one of the most distended coils, as low down as possible and drain the intestines (*vide infra*).

I propose to describe the operation generally first, and then to allude to its application to the chief forms of acute intestinal obstruction.

Operation.—The surgeon should first see that the following

are in readiness, the instruments having been boiled and placed in carbolic acid (1 in 40)—scalpels, probe-pointed bistoury, a steel director, twelve pairs of Spencer Wells' forceps, scissors, two pairs of dissecting forceps, large retractors, ligatures and fine sutures of carbolized silk and chromic gut, reliable sponges known to be clean beforehand, and soaking for two hours in carbolic acid (1 in 60), two of them being flat, two or three quarts of a 2 per cent. solution of boracic acid, kept hot, for irrigation of the peritoneal sac if needful, some new towels cut in half, rolled and soaked in warm carbolic solution (1 in 20), very fine round needles, a Keith's drainage-tube, iodoform, and iodoform gauze in strips and squares for tamponnading. One or two sizes of Paul's drainage-tubes (fig. 181) Mayo Robson's bobbins and Murphy's buttons should also be in readiness. The temperature of the room should be 80°. The precautions given (p. 751) against shock must now be taken.

The bladder is first emptied, and the abdominal wall shaved and cleansed (p. 657). A water-bed should be filled with *hot* water. The blankets on which the patient lies are protected with warmed macintoshes, and over these are spread the towels, wrung out of carbolic-acid solution, on which the instruments are placed. Hyd. perchlor. solution (1 in 3000), should be at hand for the surgeon and his assistants to dip their hands in. Anæsthesia having been induced by ether or the A.C.E. mixture, the surgeon makes a central incision,* beginning two inches above the umbilicus, and passing to the left of this he gains the middle line to descend, going quickly down to the peritonæum, but arresting all hæmorrhage before this is opened. If the linea alba is not hit off exactly, and is not quickly found, any muscular fibres are torn straight through with a steel director, and the transversalis fascia and peritonæum thus quickly reached.

I strongly advise the surgeon to give himself plenty of room, so as to quickly get his hand in and explore efficiently. A short median incision below the umbilicus, and the introduction of a couple of fingers, is usually futile. The abdominal wall in these cases is not thinned and overstretched as in ovariectomy; hence, if inadequately opened, it grips the hand most embarrassingly. If the case has been allowed to go on until the intestines are distended, the search for the cause of the mischief will be rendered all the more difficult, and there must be sufficient room to introduce the hand freely. If an assistant skilfully keep the edges of the wound together where this is not occupied by the inserted wrist, the intestines will not escape.

The peritonæum should always be well lifted up before it is opened, especially if there is distended bowel beneath. The opening is then enlarged with a blunt-pointed bistoury or scissors, two

* In those extremely rare cases where the obstruction can be localised to one or other side of the abdomen, a lateral incision may be made use of, either over the swelling, if any be present, or in the linea semilunaris.

fingers with the palmar aspect turned upwards serving now as the best director. Up to this time irrigation * with hot hydr. perchlor. solution (1 in 4000) has been made use of, but is now stopped.

Mr. Greig Smith advises, where the peritonæum is thin, to pinch it up between the finger and thumb, and roll it about to see that no bowel is included.†

The surgeon should now decide which mode of exploration he will make use of. The following is as useful as any. If the parts are not much distended, three possible sites of strangulation should be first looked to. (1) The cæcum,‡ which will give twofold evidence, first, its distension or emptiness telling whether the obstruction is above or below it; and secondly, the state of its appendix, whether normal or free, whether empty or containing some concretion. (2) Next, the internal inguinal, the femoral, and obturator rings are explored, to make sure that no tiny hernia exists, imperceptible from the outside. The fingers are next swept upwards towards the (3) umbilicus, in the hope of finding one of the diverticular bands mentioned at p. 784. If, up to this, the search has been fruitless, the brim of the pelvis is next examined, as bands of omenta are often fixed hereabouts, and also because, in women, local peritonitis, originating in the uterus or its appendages, and, in either sex, about the appendix cæci, is, not infrequently, the source of the obstruction.

If the search fail, and it often will when distension is present, embarrassing the fingers in their movements, and obscuring the relation of parts, one or two of the loops which lie nearest to the wound should be carefully scrutinized.§ These should be followed in the direction of increasing congestion and distension, thus leading to the obstruction. Fixity of a coil may be another aid. Where there is ground to believe that the case may be one of acute supervening upon chronic obstruction, the sigmoid and colon should be first investigated.

If this prove fruitless in cases where there is not much distension, the plan adopted by Mr. Cripps (*Clin. Soc. Trans.*, vol. xi. p. 225), is the simplest—i.e., to draw out some inches of intestine at a time, bit by bit, from the upper part of the wound, passing it in again into the belly through the lower part, in such a way that at

* Unless the peritonæal sac requires washing out, the surgeon need not trouble about further irrigation, if he is scrupulously careful that *everything* used is aseptic.

† If much fluid is present, it now often shows itself through the peritonæum.

‡ If the cæcum can be made out to be empty, tracing up empty coils from this will very likely lead to the obstruction. The more marked the evidence of collapsed small intestine, the greater the probability of the obstruction being high up, and the less fit the case for enterostomy (p. 821). (R. Jones, *Brit. Med. Journ.*, vol. i. 1894, p. 1123.) In this case a band was found and successfully dealt with. Here the obstruction had been incomplete at first, one of incarceration followed by strangulation. I have mentioned a similar successful case at p. 878.

§ Mr. Greig Smith says that as the most distended coils will rise nearest the surface, and the greater amount of bowel is within 3 inches of the umbilicus there is a probability that the most dilated coils will be in sight.

no time are more than 5 or 6 inches of intestine exposed. After drawing out and replacing some feet of intestine in this way, it is probable that, owing to the increasing congestion or resistance, the surgeon will reach the obstruction.* This is, however, a tedious method and one only to be adopted when the condition of the patient is good.

An assistant should hold the coil from which the surgeon starts in the lower angle of the wound under a hot sponge, so as to save the surgeon going over the ground a second time.

If a search for ten minutes has failed † to find the cause of obstruction the following courses remain open. (a) Kummell's plan of allowing the small intestines to prolapse under hot aseptic towels; (β) emptying the most distended coil, and either closing the opening later, or (γ) inserting in it a Paul's tube; (δ) "short-circuiting."

(a) The objection to this method is, of course, that it is often exceedingly difficult to get the distended coils back into their home, and that the necessary manipulations and exposure must produce shock, and may inflict serious damage.

A better plan is to empty the most distended coils, either by multiple puncture with a very fine hydrocele trocar if, which is rare, they contain only gas, or by incision if liquid fæces are present as well. Both these steps are often disappointing. Two conditions must be present to allow multiple punctures with the finest hydrocele trocar to be safe. The coats of the intestine must be sufficiently healthy, neither infiltrated nor paralysed, to allow the peritonæal and muscular coats to close the opening in the mucous by gliding over it, otherwise a fatal leakage will take place *guttatim* unless every puncture is closed by a fine parietal suture. The second condition is, that gas only must be present; liquid fæces being almost invariably present as well. A wiser course is to incise and evacuate the most distended coils. The patient being turned on to one side, the most distended loop is drawn out over a basin, incised parallel to its long axis at a point most distant from the mesentery, the rest of the coils being kept within the abdomen, and the one withdrawn carefully isolated by tampons of iodoform gauze or hot aseptic towels. As the escape of gas and fluids, owing to the paralysis of the intestine, will probably be very slow, it will be wise to follow Dr. Senn, and "resort to pouring out the contents, as it were, by seizing the gut

* If he find that the bowel is getting healthier and emptier, the surgeon must reverse the direction of his search.

† As I have said at p. 778, "the difficulty of finding the obstruction in some cases is well shown by Madelung, who, in several cases where the seat of obstruction could not be located during life, requested the pathologist, when he made the post-mortems, to locate the obstruction by introducing his hand through an incision, allowing him from ten to twenty minutes for the exploration; in every instance he failed to find the obstruction within the specified time" (Senn, *loc. supra cit.*).

several feet above and below the incision, and elevating it," a large quantity of fluid faeces being thus poured out. This emptying of distended coils will not only facilitate reduction, but, as first urged by Mr. Greig Smith (*Abd. Surg.*, p. 436), it will diminish the harmful effects of a greatly distended abdomen—viz., dyspnoea, palpitation, and abdominal shock, and, as regards the bowels themselves, the danger of continued distension, paralysis, and absorption of toxic products. When the evacuation has been made as complete as possible the next step will depend upon the condition of the patient. If this be good, and the relief of the distension has been sufficient to justify further exploration, the surgeon closes his incision in the intestine by Lembert's sutures, taking care to effect real inversion of the edges, and, leaving one or two of the sutures long, keeps this bit of intestine outside, entrusted to an assistant, while he continues his search for the cause of the obstruction. If this be found and removed the opened and sutured part of the intestine must again be inspected, and its exact closure made sure of before it is returned; any sutures left long having been first cut short. Before finally closing the wound the question of cleansing the peritoneal cavity, irrigation, and the insertion of a Keith's tube into Douglas' pouch may arise.

Where the patient's condition or the persistent distension of the intestines makes any further search impossible, the opening in the intestine must be converted into an artificial anus, temporary or permanent; or else "short circuiting" must be performed. As the last can very rarely help us in acute intestinal obstruction I will first dispose of this subject. It will be remembered that I am speaking of short-circuiting as one of the courses open to a surgeon when he fails to find the cause of an acute intestinal obstruction, or rather, of an acute supervening upon a chronic obstruction. It is evident that it is only to a few cases that this method is suitable, *e.g.*, cases of matting together of coils of small intestine, as after previous mischief set up by a mesenteric gland, or appendicitis. In such cases if there is inextricable matting but no recent inflammatory changes and nothing like gangrene, a coil of the distended small intestine may be short-circuited to the most conveniently placed piece of large intestine. This is effected by the use of a Mayo-Robson's bobbin, Murphy's button, or Senn's plates (*q.v.*), according to the surgeon's familiarity with each, and the time at his disposal. In the majority of cases where the surgeon cannot find the cause, some part of the small intestine will be suffering not from chronic matting as above, but from the pressure effects of some band, orifice in the omentum, &c., and softening, or even gangrene, may be impending; then a better plan to relieve the distended intestine will be by tying in a Paul's tube,* or puncturing with a large trocar and

* I have recorded, pp. 825, 878, a case in which this treatment saved the life of a patient suffering from strangulation of the small intestine (localised gangrene having set in) by a band.

cannula (p. 823), one of the most distended coils, this being first withdrawn and completely isolated with sterilised towels or iodoform gauze. While the distension is being relieved the parietal wound may be sutured, and the knuckle of projecting bowel attached by a few points to the edges of the wound.

Mr. Greig Smith (*Med. Chir. Proc.*, 1891-1892, p. 89; *Lancet*, 1892, vol. i. p. 582) advises that after the obstruction has been removed* the distended intestines should be emptied as follows:—Sufficient anæsthetic having been given for the painful parts of the operation—the parietal incision, the abdominal manipulations for finding the cause of the obstruction, and the introduction of the sutures—a loop of distended bowel is pulled out, shut off (*vide supra*), and as large a needle as can be connected with the aspirator is introduced. “Then aspiration is performed, but not too violently, otherwise the mucous membrane might be sucked in. Then they must sit down by the bedside and wait. In about half an hour the abdomen would be quite empty. Then they must put in a Dupuytren’s stitch and replace the intestine in the abdomen. If they were uncertain as to whether enough had drained away, a supporting thread might be put under the gut to keep it near the orifice for a few hours.” After the first gush of fluid through the aspirator it might be necessary to wait half an hour, until the successive coils had emptied themselves.† Mr. Greig Smith considered it a waste of time to suture the peritonæum to the edges of the wound. He preferred tapping three or four times during the twenty-four hours to tying in a Paul’s tube.

Where the patient’s condition does not admit of any search for the cause of the obstruction the surgeon must tie in a Paul’s tube at the spot where, in the most distended and congested coil which he can readily find, he has first aspirated (*vide supra*).

The peritonæal sac must be next cleansed of any fluids, and above all of any discharges, either by sponges introduced on large Spencer Wells’ forceps down into the pelvis and along the costo-vertebral furrows, or by flushing with a hot solution of boracic acid (2 per cent.), or $\frac{1}{2}$ per cent. of salicylic acid, in boiled water: pints of this are introduced by an irrigating tube. After

* The teaching of those surgeons who hold that finding and removing the obstruction would generally be a comparatively simple matter, is sadly at variance with the experience of many surgeons, and notably with that of Madelung (referred to at p. 781). It is very noteworthy that those English surgeons whose names are most connected with intestinal surgery, and whose large experience is well-known, have not yet published anything like a series of operations for intestinal obstruction.

† The emptying of the intestines after incision is often disappointing. This is due to the fact, as pointed out by Mr. Greig Smith, that the distended coils, confined by their mesentery, form acute flexures, down to the second or third of which the gut is emptied and no farther.

the flushing, sponges are again used, and a Keith's tube inserted. Drainage is always to be employed when the peritoneal sac has been contaminated. Further details are given at p. 817.

The opening in the abdominal walls is then closed with sutures of wire, or silk or fishing-gut, material of sufficient stoutness being provided if any tension is present. Care should be taken to include the parietal peritonæum, and, as the sutures are inserted, to prevent, by a flat sponge, any blood entering the cavity of the peritonæum.

The advisability of forming an artificial anus is alluded to below at p. 821.

Having spoken of the operation generally I shall next refer to a few practical points connected with the chief causes of obstruction individually.

I. *Strangulation by Bands and through Apertures.**

A. **Bands.** 1. *Adventitious Peritoneal Bands.*—Perhaps there has been a history of peritonitis, starting possibly from the cæcum, the uterus and appendages, or a mesenteric gland. These bands are usually attached by one end to the mesentery. 2. *Omental Bands.*—Here some part of the lower end of the omentum has become adherent to the brim of the pelvis, a hernial sac, the uterine appendages, or the cæcum. 3. *Meckel's Diverticulum.†*—This is usually met with in young subjects. Tubular or cord-like, it will be found attached at one end to the ileum, within 3 feet of the cæcum, at the other near the umbilicus, or to the mesentery or intestine. Under this arch small intestine is very liable to slip. In other cases one end is free, and ensnares or knots up a loop of intestine. 4. *Some Normal Structure abnormally attached, e.g., the Fallopian Tube or the Appendix.‡*

In most cases bands, when found, are not difficult to deal with. If they do not give way to the finger as attempts are made to hook them up, they should be divided between two ligatures of chromic gut. Occasionally transfixion is required. When one band has been discovered, the possibility of a second, attached to the pelvic brim, must always be remembered.§

Two other points connected with bands must be remembered; one, that if they are vascular both ends should be secured. The

* Mr. Treves (*Intest. Obstruct.*, p. 13; *Dict. of Surg.*, vol. ii. p. 802) groups these together from the similarity of their obstruction and their close resemblance to strangulated hernia.

† A most interesting and fully reported case successfully treated by laparotomy was published in the *Lancet*, March 9, 1889, by my old friend R. J. Pye-Smith, of Sheffield. Two others successfully treated in the same way by Mr. Clutton (*Clin. Soc. Trans.*, vol. xvii. p. 186) and Mr. McGill (*Brit. Med. Journ.*, January 14, 1888) will well repay reference.

‡ One classification of bands useful to the operator is into those easily found, and those which are inaccessible.

§ A case in which no fewer than three bands were present, the intestine being found sloughy under one of them is recorded (*Lancet*, vol. ii. 1892, p. 192).

other, that on the division of the band the piece of intestine which has been released may be found to be gangrenous or even perforated, and allowing its contents to escape into the peritoneal sac. The intestine must then be brought outside and drained, and the peritoneal sac cleansed if possible (p. 817).

Every band should be resected as closely to its attached points as is safe, to prevent any recurrence of the trouble. In the case of a diverticular band which is tubular, the contiguous peritoneal contents being all shut off with sponges or tampons, the diverticulum and the intestine into which it opens are emptied by pressure. Then the diverticulum, being lightly clamped, is divided, $1\frac{1}{2}$ or 2 inches from the intestine, the mucous coat is disinfected with pure carbolic acid and tied with silk or sutured with a few silk sutures, while a second row, which takes up the muscular and serous coats, gives further security.

B. Apertures and Slits.—These may be congenital or traumatic. The two following cases are good instances, and show in sharp contrast the difficulties which may be met with :

In Mr. Howard Marsh's case (*Brit. Med. Journ.*, June 2, 1888) a loop, probably in the middle of the jejunum, had slipped through a hole in the mesentery. The edge of this opening was so yielding that Mr. Marsh could readily stretch it with his fingernail sufficiently to allow the loop to be drawn out. The patient made a good recovery, though in much danger, for a while, from the paralysed condition of the intestine.

In Mr. Treves' case (*Oper. Surg.*, vol. ii. p. 389) the intestine was strangulated in the foramen of Winslow. Here the surgeon not only could not reduce the gut by operation during life, but at the autopsy he could not bring about reduction until the hepatic artery, portal vein, and bile duct were severed.

In the case of either bands or apertures it is the lower part of the ileum which is usually strangulated.

II. Intussusception.—From its frequency, especially in early life, its fatality in infants, and the fact that its treatment is less unsatisfactory because its diagnosis* is easier than other forms of obstruction, this deserves careful notice. Of the varieties—the enteric, the colic, the ileo-colic, and the ileo-cæcal—the frequency of the last is well-known. It is to this variety, especially in children, that the following remarks mainly apply.

With regard to *treatment*, it cannot be too strongly insisted upon that, in this form of obstruction, there is no excuse for delaying active steps. If intussusception is suspected no time should be lost in trying inflation or injection. I prefer the former. A little A. C. E. mixture being given, the lower limbs being somewhat raised, the nozzle of a Lund's inflator, or a full-sized catheter, or a rectal tube, attached by tubing to a bellows and well coated with vaseline, is carefully passed into the bowel. The nates being

* Two points must always be remembered in the diagnosis of intussusception : (1) that in cases which are not acute there may be very few symptoms for some time. (2) The rectum must always be examined, and any intussusception which may be met with not mistaken for a prolapsus.

securely pressed round the tube, air is steadily pumped into the colon, while the surgeon keeps one hand on the abdomen, not only to prevent over-distension, but also to watch for any receding of the tumour towards the cæcal region.

With regard to the force used, Dr. Goodhart (*loc. supra cit.*, p. 125) remarks: "Replacement of the bowel can usually only be effected by considerable distension of the whole colon, and distension of the colon sometimes requires a good deal of rather forcible pumping to complete it." This is especially the case with regard to the last few quantities of air sent in. Dr. Taylor's* advice here will minimize the risk of rupture of the bowel: "The risk can be reduced to a minimum by injecting, carefully and slowly, successive small quantities, and by gently kneading the abdomen so as to facilitate the passage of air upwards, and thus prevent the sudden over-distension of short lengths of the colon."

Inflation failing, while the child is still under an anæsthetic, abdominal section should be at once proceeded with. Before describing this, it may be useful to point out, as far as this is possible, in what cases it is likely to be called for and how often it is likely to be successful. The following considerations will help towards an answer to the above questions:

a. The duration of the case. In the majority of cases, especially in children, the tendency of the condition is to strangulation, and not incarceration, and while the rapidity of the strangulation varies a good deal, the chances of inflation or injection are small, unless in recent cases. β. If this is correct, it is obviously of much importance to decide whether the bowel is strangulated or incarcerated. Mr. Hutchinson (*Med. Chir. Trans.*, vol. lvii. p. 31) points out that the severity of the symptoms will be helpful here—viz., the urgency of the vomiting, the degree of the constipation, the character of any stools passed,† &c., any indications of collapse, and, above all, as utterly incompatible with gangrene.

* *Clin. Soc. Trans.*, vol. xvi. p. 71. Dr. Taylor thinks that two kinds of cases are unsuited for inflation: One, in which the intussusception actually projects from the anus, as this form shows enormous forcing power on the part of the intestine, while, after replacement by the fingers, the amount of air that can be brought to bear is necessarily small. Dr. Taylor's other group unsuited for inflation is where no tumour can be felt and the diagnosis depends solely on symptoms. He points out that here it is impossible to judge of the effects of inflation.

† Dr. Fagge and Mr. Howse (*Med. Chir. Trans.*, vol. lix. p. 90) pointed out that blood in the stools of these cases does not necessarily mean strangulation and threatening gangrene. Thus it may be present, in chronic cases, from the first, as in Mr. Hutchinson's, where blood-stained mucus was passed for a month, at the end of which time Mr. Hutchinson was still able to reduce the intussusception by a successful operation. In other chronic cases no blood may be passed for a long time; it may then appear with other symptoms and rapidly destroy life, though no gangrene is present. Lastly, in some of the cases in which the bowel has sloughed away, no blood has, at any time, been passed.

advance of the tumour further on in the large intestine.* γ . The condition of the patient as to collapse, &c. δ . Age. In infants under a year, unless reduction is early tried and is quickly successful, the prognosis is very desperate, whether an operation is performed or no. Mr. Hutchinson thinks that this fact may be held to justify very early resort to operation.

Operation.—The child being still under the influence of the A. C. E. mixture, the parts being cleansed, and any urine drawn off, an incision is made, usually in the middle line,† sufficient to admit of the easy introduction of two or three fingers. Before opening the peritonæal sac the bleeding should be entirely arrested. The intussuscepted mass is now found, and, if possible, hooked out into the wound. But more often this is impossible, and the reduction must be effected *in situ*.

Dr. Senn advises (*loc. infra cit.*, p. 128) that: “The œdema and inflammatory swelling should be removed before any attempts at reduction are made. This can be readily accomplished by steady and uninterrupted manual compression of the invaginated portion.” My own experience here is disappointing.

The following points must now be carefully attended to. If the intussusception cannot be brought outside, two fingers of each hand should be introduced, and an attempt made (1) to draw out the intussusception while the point of entrance is held steadily. As a rule, this is only partially successful. (2) The lower end of the invaginated part being found, the ensheathing layer should be pulled down, while the ensheathed part is pushed up. When the end of the intussusception has reached the rectum help may be given by an assistant with a bougie; but it will usually be found that pushing or backing out the contained bowel by gently squeezing movements between the finger and thumb, these being gradually shifted along the gut will prove successful, when, by no force that is justifiable, could any part be drawn out.

Whichever method is found to answer best must be persevered with until every atom of the mass is reduced, this being often known by the appearance of the vermiform appendix.

If, when the reduction is complete, any tears are noticed in the peritonæal coat, these must be sewn up with a fine silk continuous suture, and a little iodoform rubbed in.

Every care should be taken throughout the operation to prevent chilling, both of the child's body and limbs, and especially of any intestine which may have to be withdrawn. The precautions given at p. 770, as to instruments, irrigation of wound, and of

* Dr. Goodhart (*loc. supra cit.*, p. 122) points out that, while this symptom means that no sloughing and no firm adhesions are present, it cannot be inferred, owing to the œdema and inflammation which are already present, that because the tumour thus alters its position, therefore it can be reduced.

† As speed is very important in these cases in children the surgeon should give himself enough room by beginning above the umbilicus. The intussusception usually lies deeply and is difficult to get at.

the peritoneal sac if needful, and closure of the wound, should be adopted.

As in all abdominal sections, this operation should be concluded as speedily as may be.

When the intussusception cannot be reduced, all attempts at traction and kneading only causing tears in the peritoneal coat, the following courses are open according to the condition of the patient, &c. (1) If the collapse is already great, and the operator short-handed, he may be compelled to close the wound and do no more. (2) If the intussusception is gangrenous but small in amount, should be resected. For the union of the divided ends Murphy's button has the great advantage of saving time and is thus well adapted to acute and subacute cases in children, which form the majority of the cases. Whatever method is used some difficulty must be expected in effecting exact union in the common variety, the ileo-cæcal, owing to the difference of the lumen in the two parts of the bowel; where this difficulty is very marked, the best plan will be to close both ends by a double row of sutures, continuous and Lembert's, and then to make a lateral anastomosis (*q.v.*) by means of Murphy's button, Robson's bobbin, &c. (3) If the invagination is irreducible but not gangrenous, it may be left, and the continuity of the canal restored by short-circuiting the small and large intestine above and below the invagination by Murphy's button or some other means. (4) Where the patient's condition is good, as in chronic cases, an irreducible intussusception may be removed by an operation based by Mr. Jessett (*Surgical Diseases of the Stomach and Intestines*, p. 140), on what is known as a spontaneous cure. It was three times performed successfully on dogs. An invagination having been made artificially, and found a week later firmly adherent it was thus removed. A longitudinal opening was made into the intestine over the root of the intussusception on the side farthest from the mesentery, about $1\frac{1}{2}$ inches long, of sufficient length to allow the invaginated part to be drawn out with vulsellum forceps. The root of the invaginated part having been pulled out through the above opening, was cut through close to its origin, any vessel which required it being tied. Then the divided coats where the intussusception had been cut away were united with a few points of suture, the lumen of the bowel being left open. The stump was then returned into the intestine, and the incision in this closed by quilt sutures. Other and less desirable methods which may be thrust on the surgeon owing to the circumstances under which he operates are: (5) Resection and formation of an artificial anus.* (6) Formation of an artificial anus without resection. Finally in those rare cases of invagination of the colon into the rectum the intussusception may be drawn down and removed by the operations of Mikulicz, or Mr. Barker in this country. The latter surgeon's cases will be found in the *Med. Chir. Trans.*, 1887, vol. lxx. p. 335, and *Brit. Med. Journ.*, vol. ii. 1892, p. 1226. In both cases a malignant growth was at the root of the invagination, and in each operation steps were facilitated by the ease with which the growth after dilatation of the anus could be pulled outside. Two rows of sutures were made to encircle the bowel, and to unite the two layers of the intussusception firmly together well above the new growth. As the sutures were passed care was taken that no small intestines protruded. Both cases recovered, and the first was alive four or five years after the operation.

III. Volvulus.—The intestine here is usually either twisted on its mesenteric axis, or bent at an angle. The first is the acuter

* Prof. Senn quotes a case of Wassiljew's (*Centr. j. Chir.*, 1888, No. 12), in which an operation was performed to close the artificial anus six months later. It was ultimately successful.

condition, owing to the strangulation of vessels. It is usually met with in the sigmoid flexure, when this has a long meso-colon, especially in adults who have been subject to constipation (Treves). The distension may be enormous, the sigmoid appearing to occupy all the abdomen. Ulceration leading to fatal peritonitis may set in, either in the sigmoid, the colon, or cæcum.

A free incision will be required here, so as to enable the surgeon to get at the root of the volvulus. The volvulus may present at once as a hugely distended coil; it may be felt as a localised collection of intestine; if twisted, the twist may feel like a band, and a band may actually complicate the case as when a vermiform appendix is coiled round the root of the twist of the volvulus. (*Brit. Med. Journ.*, vol. ii. 1892, p. 170). If attempts at reduction fail, the volvulus should be drained by tapping or incising the summit of the loop, this being brought outside the peritonæal cavity.* Fresh attempts at reduction are then made, and if they succeed, and if there is no tendency for the volvulus to return, the opening is closed, and the intestine thoroughly cleansed and returned. If reduction is impossible an artificial anus must be made immediately above the volvulus, this having been first completely emptied and closed.

In a very few cases where the volvulus is persistent, and, at the same time, of small extent, it may be resected if the patient's condition admits of it. But volvuli of small extent can usually be reduced.

The following points are noteworthy in the diagnosis and treatment of volvulus. It is not uncommon for this form of obstruction to follow an injury,† some loop of bowel distended with fæces, and with a long mesentery probably becoming suddenly displaced and unable to recover itself. Again, this form of obstruction has been noticed, whether as a mere coincidence or not, in many cases in the insane. Finally, at the time of treatment, Mr. Treves' warning (*Oper. Surg.*, vol. ii. p. 390) must always be remembered: "The reduction of a volvulus does not usually remove the anatomical condition that led to it." The truth of this is shown by their tendency to recur.

Thus Mr. Greig Smith (*Abd. Surg.*, p. 450) mentions a case of volvulus of the small intestine which recurred a week after it had been untwisted by abdominal section. Enterotomy was then performed, and the patient for some time wore a catheter in the opening to allow of the passage of flatus into a bottle which he carried in his pocket. After some time the distended bowel had so contracted that the use of the catheter could be dispensed with. Dr. Finney reports (*Johns*

* Where the loop is so large that it cannot be brought out through the wound it must be tapped or aspirated *in situ*, additional care being taken to prevent infection of the peritoneum and its contents.

† See cases mentioned by Mr. Turner, Dr. F. Hawkins, and Mr. Stavely (*Lancet*, vol. ii. 1892, p. 995); a case successfully operated on by Mr. Silcock (*Clin. Soc. Trans.*, vol. xxviii. p. 180). References are made in this paper to eight successful cases operated on abroad.

Hopkins Hosp. Bull., March 1893), a case of volvulus which involved the whole colon between the ileo-cæcal valve and the sigmoid, it was rectified by operation, and recurred nearly three years later. A second recovery followed.

Prof. Senn has advocated shortening the meso-colon to meet this tendency to recurrence. Fixation of the colon by two or three points of suture might be tried as less risky, if access is not prevented by distension of the small intestines. In any case, great care will be needed by such patients in their diet and to ensure efficient action of their bowels.

IV. *Gall Stones, Intestinal Calculi, &c.* — Gallstones, the most common of these, present cases very favourable for operation if taken in time, owing to the simplicity of the cause of obstruction, and the facility with which it may be usually dealt with. Operation has been here too often deferred, owing to the fact that these patients, usually advanced in life, and stout, are not well suited to operation from a general point of view, and because it has been strongly insisted upon by some that if pain and spasm can only be removed the local cause of the obstruction will pass on. This I believe to be a mistake. Mr. Treves (*Intestinal Obstruction*, p. 335) states that of 20 cases in which gallstones “produced definite and severe symptoms of obstruction” 6 patients recovered by the spontaneous passage of the stone, and 14 died unrelieved. It is to be hoped that the successful cases which have been published, one as long ago as 1887 (*Lancet*, December 3), by Mr. T. Smith, Mr. Clutton (*Clin. Soc. Trans.*, vol. xxi. 1888, p. 99), and more lately by Mr. A. Lane (*ibid.* ii. 1894, p. 382), and Mr. Eve (*Clin. Soc. Trans.*, 1895, vol. xxv. p. 91),* may bear good fruit. In some cases, in addition to the age, stoutness, and habits of the patient, the history of previous inflammation in the neighbourhood of the gall-bladder may help the diagnosis; in 4 cases, certainly, the calculus has been felt—the abdomen being undistended—before operation. But in the majority it is probable that here, as elsewhere, operation alone will clear up the cause of the obstruction.

The following courses may be adopted: (1) To try and pass on the stone through the ileo-cæcal valve into the large intestine. Mr. Clutton (*Clin. Soc. Trans.*, vol. xxi. p. 99) succeeded in doing this, the stone being situated 8 inches above the valve. But usually the stone is too firmly fixed.

Mr. Clutton's case is a very instructive one. The patient, a woman aged seventy, was operated upon within twenty-four hours of the beginning of the attack. Fifteen months before she had passed a large facettèd biliary calculus, and after her recovery from this had had a swelling in the region of the gall bladder. This disappeared with the onset of the obstruction. A median incision four inches long having been made, the stone was readily felt, and though it tightly fitted the lumen of the intestine it could be forced along. As owing to the early date at which the operation was performed, there was no marked difference between the intestine above and below the obstruction, the site of the ileo-cæcal valve was determined

* In this paper some 30 cases which have been treated by abdominal section are given and the result considered.

by making out the cæcum and the appendix. There was not much difficulty in urging the calculus in the right direction, but as soon as the valve was reached some considerable force was required to make it pass through. This most successful case strongly supports Mr. Clutton's advocacy of an early operation, before the stone has become so immovable as to require opening of the intestine.

Dr. Maclagan (*ibid.*, p. 97), draws attention to an important point. If other stones exist in the gall-bladder or ducts, another may descend before the wound is healed, and, forcing its way through the recent incision, cause fatal peritonitis.

(2) If the stone does not feel very hard a cautious attempt may be made to crush it between flat-bladed forceps, guarded with drainage tube. Such a course can only be adopted when the intestine immediately adjacent to the stone is healthy. (3) The same precaution must be taken if Mr. Tait's suggestion of breaking up the stone with a needle is resorted to. If used, the needle must puncture obliquely, $1\frac{1}{2}$ inches from the stone. (4) If the stone cannot be pushed onwards, and if it is too hard to be broken up, it must be removed. The loop being drawn well outside the peritonæal cavity, an incision must be made in the intestine opposite to the mesenteric border, the calculus removed, care being taken that its long axis corresponds with that of the wound and that the edges of this are not bruised. The wound is then closed most carefully with Lembert's or Halstead's sutures, silk being used. Whichever of the last three methods is resorted to, the stone must, if possible, first be pushed in to an absolutely healthy part of the intestine, if that surrounding it is inflamed or thinned. (5) If the condition of the intestine is suspicious, or if, on opening it for the removal of the stone, the mucous coat is ulcerated, one of the three following courses must be followed, according to the condition of the patient, and the resources of the operator—viz., (a) Resection and union of the ends by Robson's bobbin, &c. (β) Formation of an artificial anus. (γ) Where the operator is doubtful if his sutures will hold, but desires to give this method a chance, he will suture the wound of extraction and then bring this outside, packed around with iodoform gauze for 24 or 48 hours, or leave it just within the abdominal wound, anchored here by a catgut stitch, and shut off from the rest of the peritonæal sac by tampons of iodoform gauze (wrung out of 1 in 20 carbolic-acid lotion), the ends of which are brought out through the parietal incision.

V. *Thrombosis of the Mesenteric Vessels or of Abdominal Aorta.*—In closing this account of the chief varieties of intestinal obstruction, mention must be made of the above conditions, as it is clear, from the cases published, that, though rare, they may simulate acute intestinal obstruction very closely. The explanation appears to be that a loop of intestine, deprived of its blood-supply by an embolus will, functionally, be as completely paralysed as it had been strangled. Instructive cases of this kind will be found published by Mr. McCarthy (*Lancet*, vol. i. 1890, p. 646), and Dr. Munro, of Middlesbrough (*ibid.*, vol. i. 1894, p. 147).

Dr. Munro quotes from Gerhardt and Kussmaul the following diagnostic points of these cases : (1) A source of origin for the embolus ; (2) profuse hæmorrhage from the bowels ; (3) severe colic-like pains in the abdomen ; (4) rapid reduction of temperature ; (5) demonstration of an embolus in some of the other arteries ; (6) palpation of infarcts in the mesenteries. In Dr. Munro's case, one of these, situated in the meso-sigmoid, could be felt, before operation, in the left iliac fossa. To these points might be added advanced age and no evidence of malignant disease. The mischief is usually too extensive to admit of surgical interference. If it be limited to the small intestine, several branches are usually plugged.

Before closing the account of the surgical treatment of acute intestinal obstruction I must allude to two points, owing to the illustriousness of the names which introduced them : I refer to Prof. Senn's* advice to try insufflation with hydrogen, in order to find the seat of obstruction, and Mr. Hutchinson's abdominal taxis.

Prof. Senn, finding that distension of the entire gastro-intestinal canal (for, owing to distension of the cæcum, the ileo-cæcal valve is paralysed) in animals was never followed by any ill effects, has advised this (1) in reduction of intussusception, (2) in locating the obstruction during a laparotomy, (3) in detecting the site of gunshot or other perforations of the intestine. The gas is collected in a 4-gallon rubber balloon, and the inflation made by compressing the balloon. A manometer or mercury gauge connects, by rubber tubing, the rectal tube on one side and the balloon on the other.

This method, though extremely ingenious, is likely to have but a limited application. In the reduction of intussusceptions the use of ordinary air is much more handy, and has been abundantly successful. In the detection of perforations, especially those by gunshot, the test has certainly answered, but the following *risks* are connected with its use. It will demonstrate perforations, but nothing else, and may lead the operator, if he trusts to it, to overlook many other lesions which may be as dangerous as perforations themselves. Many conditions—*e.g.*, impacted fæces, prolapse of mucous membrane, and recent adhesions—may interfere with its efficacy (Morton). Though aseptic when introduced, the gas can hardly be so after passing through many feet of intestine. It may break down most vital adhesions. It may increase, by the distension it causes, the danger of the anæsthetic, and is, of course, only available in cases where there is little, if any, distension.

Abdominal Taxis.—This has been advocated by Mr. Hutchinson for over thirty years, with the object of causing very considerable movement of the abdominal contents, and thus effecting replacement, if the taxis be adopted before swelling has occurred, or adhesions formed. In support of his advocacy Mr. Hutchinson appeals "to the well-known facts as to the looseness of many bands, the large size of many apertures, the slight character of many twists, the smallness of the strangulated loop in many cases," and has advanced, more than once, an opinion "that the evidence is in favour of the belief that these forms of strangulation are often, in early stages, effectually relieved without operation; that, in fact, cases of recovery without operation, after any acute symptoms, are not uncommon" (*Archives of Surgery*, p. 3).

* *Loc. supra cit.*, p. 53; and *Journ. Amer. Med. Assoc.*, June 1888: "Rectal Insufflation of Hydrogen Gas an Infallible Test in the Diagnosis of Visceral Injury of the Gastro-intestinal Canal in Penetrating Wounds of the Abdomen."

"The first point in abdominal taxis is the full use of an anæsthetic, so as to obliterate all muscular resistance. Next (the bowels and bladder being supposed to be empty) the surgeon will forcibly and repeatedly knead the abdomen, pressing its contents vigorously upwards, downwards, and from side to side. The patient is now to be turned on his abdomen, and in this position to be held up by four strong men, and shaken backwards and forwards. This done, the trunk is to be held feet uppermost, and shaking again practised directly, upwards and downwards. Whilst in this inverted position, copious enemata are to be given. The whole proceedings are to be carried out in a *bonâ fide* and energetic manner. It is not to be the name of taxis, but the reality, and great patience and perseverance are to be exercised.* The inversion of the body, and succussion in this position, is on no account to be omitted, for it is possibly the most important of all. I do not think I ever spend less than half or three-quarters of an hour in the procedure."

Later on (p. 135) Mr. Hutchinson writes that he "fully recognises the propriety of exploratory laparotomy in cases in which the symptoms have persisted after one or more persevering attempts at taxis under anæsthetics, although even here I may confess to serious misgiving that operations will not, on the whole, tend to reduce the mortality."†

It cannot be too strongly insisted on that this method of abdominal taxis can only be safely used in the early stage of acute cases, and that evidence of peritonitis, a condition notoriously difficult of diagnosis, absolutely contra-indicates abdominal taxis.

Several cases in which Mr. Hutchinson used this method successfully will be found in vol. i. of his *Archives of Surgery*.

APPENDICITIS.‡

Before discussing the question of surgical interference here, it will be well to make plain what we mean when speaking later of **the varieties** of this disease. These are:

i. *Catarrhal and Early Interstitial Appendicitis*.—Here the inflammation is limited to the mucous membrane and the other coats of the appendix, but goes no farther (if the attacks be slight) than at the most a little plastic peritonitis and a few slight adhesions.

ii. *Appendicitis with a Localised Abscess*.

iii. *Acute Perforating Appendicitis and Suppurative Peritonitis*.—Of these two

* "It is to be admitted, respecting abdominal taxis, that it is a troublesome and somewhat undignified procedure, affording no scope for the surgical skill which a laparotomy requires."

† If my readers will refer to Mr. Hutchinson's speech at Bath (*Brit. Med. Journ.*, vol. ii. 1878, p. 305) they will find his opinion still more strongly expressed and his aversion to operation still more decided.

‡ I use this term, etymologically unsatisfactory, because it is convenient and based on correct pathology.

last, the first may at any time lead to a general peritonitis; the second, if left, always does so.

iv. *Relapsing or Recurrent Appendicitis.*

Question of Operative Interference.

In this country, as it has been agreed that the great majority of the cases of appendicitis recover under medical treatment while in the first stage, physicians have usually only called in surgical help when pus has formed either as a localised abscess or as a diffuse suppurative peritonitis, or in cases of recurrent trouble. On the other side of the Atlantic the question has advanced much farther, and now presents itself as what is the earliest date at which surgery should interfere to prevent the formation of an abscess or the far graver suppurative peritonitis.* On the one hand are well-known American surgeons, to whose labours in abdominal and other fields English surgery is under a heavy debt (*e.g.*, McBurney, Senn, Murphy, Fowler, Morris, and many others), urging that the appendix should be removed at the earliest possible moment that the appendicitis is diagnosed. These advocates of this advanced or radical plan base their advocacy on the following claims: (1) That as appendicitis is an infective† disease, and as in a certain proportion of cases the infection will run very quickly into a general peritonitis, and as it is impossible to diagnose these cases at the outset from the milder ones, and as, almost at the outset, they begin their rapid course downhill, the only way of treating them and of saving their lives is removal of the appendix as soon as ever appendicitis is correctly diagnosed. (2) That this early removal of the appendix will prevent all relapses of appendicitis, and, so, much suffering and crippling of active lives, and, moreover, a few lives will be saved. (3) Removal of the appendix is, nowadays, a perfectly safe operation if performed at this early date and thus in uncomplicated cases.

On the other side are a very large number of writers on this subject, including the great majority of surgeons in this country, and especially Mr. Treves, who originally gave a great lead to this movement, and who has sedulously interested himself in it since, publishing from time to time the results of an experience unequalled amongst us in carefully weighed and authoritative papers. This camp of opinion holds that the great majority of cases of appendicitis start and run their course as mild ones. They agree that it is impossible to diagnose, at their outset (when surgical interference would be most useful), those cases which occasionally occur of "fulminating" appendicitis, which run on quickly to a general suppurative peritonitis, and while recognising the great risk of these cases, they reply that they form but a small minority, and that the risk of wholesale routine operating is decidedly greater, and would involve a much higher mortality. One careful writer on this subject goes farther, and holds that in these cases of "fulminating" appendicitis removal of the appendix, however early, would be of doubtful efficacy. "I am myself inclined to doubt whether in the majority of the cases of general peritonitis, having a sudden onset, excision of the appendix, however early (unless perhaps in the first two or three hours), would be of any avail" (Hawkins' *Diseases of the Vermiform Appendix*, p. 129).

They also deny that removal of the appendix is so absolutely safe as is represented, and maintain that recurrence of attacks may usually be prevented by

* This point deserves careful attention, lest the truth be that in this matter England's surgery has fallen behind.

† Dr. R. T. Morris, of New York, put this very tersely as follows: "I am in favour of early operative treatment in practically all cases of appendicitis, in view of the fact that the inflammation is so infectious in character. So long as the patient chooses to carry about with him a hive of bacteria, he knows not just when or where they will swarm" (*Ann. of Surg.* vol. ii. 1893, p. 365).

care on the part of the patient. Finally they would represent that the frequency with which the inconvenience of a ventral hernia may occur after this operation has been somewhat unduly made little of.

Such is, I think, a fair expression of the two camps of opinion on this subject.

For my own part, looking on the appendix as a useless* and often a treacherous organ, I consider that any physician is justified in asking a surgeon who is skilled in abdominal surgery and who has the necessary aids, &c., to remove the appendix at once as soon as the diagnosis is made. Again, I hold very strongly that every physician is not only justified in, but bound to, ask a surgeon skilled in this branch of surgery to interfere at the earliest possible moment in certain cases—viz., where the evidence of appendicitis is from the first severe and progressive. Of the evidence, the most valuable points are marked pain, tenderness, and vomiting. Next in value to these I should place the temperature and pulse. These may be fallacious,† the temperature sometimes falling and perforation taking place a few hours later. Another guide to which I attach much importance is the early look of grave illness or anything approaching to the pinching of the “facies Hippocratica.” Two other points of evidence which are of great importance, but which, it is to be hoped, the surgeon will be allowed to try and forestall, are a tendency for the abdominal wall to become fixed, and a tympanites spreading from the right iliac fossa.

I should like to call attention to one other point to which I attach great importance if it can be made out, and that is, the position of the most marked tenderness, resistance, and swelling, if present. The more internal to McBurney's point this evidence is found, the greater the risk that perforation will light up a general peritonitis instead of one limited to the iliac fossa. We have learnt much of late years from American writers (*e.g.*, Bryant and Fowler) of the importance of remembering the position of the appendix (*Ann. of Surg.*, vol. i. 1893, p. 164; vol. i. 1894, p. 12). It is clear that when the appendix is directed internally, not only is the risk of general suppurative peritonitis greater if the appendix perforate, but if a localised abscess form, it is more likely to communicate with the pelvis, and perhaps open into the rectum or vagina; if adhesions form about it there is a greater risk of much more important structures being involved, viz., the iliac vessels, ureter, bladder, &c., than if the appendix be directed downwards, when it may be only adherent to Poupart's ligament. Many other instances of the practical bearing of anatomy upon the different positions of the appendix will suggest themselves.

I will now allude to one sign which I have not given above, viz., swelling. It cannot be too strongly insisted upon that in these cases of “fulminating” appendicitis there may be no swelling from first to last.‡

* I would draw a very distinct line between a more frequent resort to removal of the appendix and a somewhat similar operation which came into fashion a few years ago—viz., removal of the ovaries. A diseased ovary may cripple, but very rarely kills; a diseased ovary is not a vestigial structure, and, though unsound, is by no means always functionless; finally, a diseased ovary is a sexual organ, and thus has peculiar relations not only to its owner, but also, it may be, to others; relations, again, quite *sui generis*.

† In Mr. G. Barling's words (*Brit. Med. Journ.*, vol. i. 1895, p. 1135), “The temperature is an uncertain guide, and one only to be relied upon when confirmed by other phenomena. If it present the paradox of a falling temperature with a quickening pulse the improvement in the former would be a fallacious guide. . . . The great point in recognising these cases is not to regard any one point as essential to diagnosis. It is desirable to dwell not too much on the absence of one particular feature, as upon the intensity of those which are present.”

‡ A good instance of the truth of this was given by some cases mentioned by

In a very few cases swelling is absent from the right iliac fossa, but present elsewhere owing to the appendix being misplaced. Thus, a very few cases of left-sided appendicitis have been recorded. Dr. Fowler (*Ann. of Surg.*, 1894, vol. i. p. 160), publishes a case in which there was marked tenderness in the direction of the gall bladder. No appendix could be found in the usual place, as it lay behind the liver.

It will be seen that the above opinion of mine that any physician is justified in asking a surgeon skilled in this branch of surgery to operate in given cases of appendicitis in the earliest stages, and that he is bound to do so where certain evidence just given points to probable rapid perforation, is not the same thing as sanctioning the removal of the appendix as a routine practice by any one who thinks himself competent to do so. Considering the increasing tendency at the present day for surgery to be taken out of the hands of properly qualified surgeons, men with a *bond fide* and life-long hospital training, and for it to pass into the hands of those who have no such ripe experience, no such operative training, and who are occupied with other work and other claims not always running on smooth lines with aseptic surgery—considering this and its effects, any such wholesale and routine removal of the appendix would be attended with disastrous consequences.

Operative Interference in Appendicitis with Abscess.

—When, a few years ago, surgery was more frequently resorted to for this form of suppuration there was a tendency to wait until the abscess was thought to be safe, *i.e.*, till it was walled in by adhesions, and generally till it showed signs of being adherent to the abdominal wall, the reason given being that, if opened before, the risk was great that the peritonæal sac would become affected. On the other hand, it is clear that in waiting we run serious risks, for: (a) the abscess may rupture and burst into the peritonæal sac, especially if the patient is restless; (b) the pus will burrow, *e.g.*, into the pelvis, opening into the rectum or bladder, downwards under Poupart's ligament, or backwards and upwards to the loin, all these directions being influenced by the position in which the appendix was lying before the attack (p. 795).

These risks being increasingly recognised there is a greater tendency to try and find the pus early. The following is the best evidence as to the early existence of pus. Marked local resistance and tenderness,* a persistent and usually progressive swelling,† Otherwise obvious points are the time-honoured ones of the hectic character of the temperature, œdema, fluctuation, and redness.

The question of resorting to the exploring needle must now be alluded to. This has been advocated by some American surgeons. Mr. Treves (*loc. supra cit.*) strongly condemns it, as: (1) It is not free from risk, as the needle may be thrust into important parts; (2) It may tap an appendix distended with fœtid mucus, and, allowing some of this to escape, bring about a suppuration which was by no means inevitable; (3) an incision is more reliable.

Operation.—The skin having been shaved and cleansed (p. 657)

Dr. Tyson, of Folkestone, at one of the discussions on this subject at the Clinical Society (*Lancet*, vol. i. 1892, p. 424). In three cases in which after mild symptoms had lasted for three days, there was sudden collapse and death. There had been sickness and tenderness, but no swelling. Operation was performed in one case unsuccessfully. In all three suppurative peritonitis following perforation of the appendix was found.

* This may be masked by unwisely given opium.

† The swelling may be very slight or difficult to detect from the rigidity of the abdominal walls and the flinching of the patient unless an anæsthetic be given.

an incision three to four inches long is made, if there be no swelling,* much as for ligature of the external iliac,† bisecting McBurney's line and lying about one inch and a half above Poupart's ligament. The inner extremity should not open the deep epigastric vessels. The peritonæum having been reached this is most carefully opened,‡ all bleeding having been previously arrested. *The appearances will now differ accordingly as the surgeon is operating to relieve the patient of an abscess or of an appendix which is on the point of rupture. The second condition will be taken first.* There may be an entire absence of adhesions, the appendix being swollen, thickened and rigid; or thickened and contracted at one spot, and dilated beyond, the "cystic" § form of appendix of some writers. There may be gangrenous patches at tip or base,|| or the appendix, itself gangrenous, may be embedded in gangrenous adhesions.

The treatment of the appendix must vary with its condition and the state of the patient. It should always be removed if possible. The wound being well opened out and the adjacent peritonæal contents having been shut off with tampons of iodoform gauze, the appendix is separated, if possible, from any adhesions present, and dealt with according to one of the following methods. If gangrenous it should be cut away as near to the cæcum as is safe, and, if its coats here will not bear ligature and sutures, the stump must be disinfected with pure carbolic or nitric acid, and one end of a strip of iodoform gauze wrung out of carbolic-acid lotion (1 to 20) placed in contact with the stump, and the other brought outside the abdomen, sufficient of the wound being left open for the renewal of this. Any adhesions that are sloughy or gan-

* This incision is very greatly to be preferred to one in the linea semilunaris and *à fortiori* to one in the linea alba because it gives very much more direct access to the parts desired. If one in the linea semilunaris be made it will be found that the outer edge of the wound often requires to be strenuously drawn aside to enable the surgeon to get at the appendix. This use of the retractor may lead to bruising of the wound. Again, if a surgeon working in the linea semilunaris needs, as is often the case, to come low down, the deep epigastric vessels must be divided.

† Before operating it will be well to percuss the line of incision. If there be a swelling with resonance over it, this may be due to intestine or to an abscess containing gas.

‡ If adherent intestine is present the incision must be extended so as to open a normal part of the peritonæal cavity.

§ This would seem *à fortiori* to be a very dangerous condition, for if the patient recover from one attack with a cystic condition, the appendix may give way at this weakened spot during the next attack.

|| Dr. Fowler (*Ann. of Surg.*, vol. i. 1894, p. 332) had the great good fortune to open the peritonæal cavity after the appendix had perforated, but before any of its contents had escaped. "The appendix, absolutely free from adhesions, was swollen to the size of a little finger, and perforated in two places. These were minute openings, through which soft fæcal matter oozed as the ligature was tightened about the base of the organ preliminary to its excision." The patient made a good recovery.

grenous, and that cannot be snipped away, should be scraped out with a sharp spoon, disinfected as far as possible in the same way as the stump, the healthy parts, lips of the wound, &c., being kept away from them by iodoform gauze.

When the appendix is inflamed and soft, but not actually gangrenous, it will be quite sufficient to trust to ligature with medium-sized sterilised silk, about $\frac{3}{4}$ inch from the cæcum. If the state of the patient or the softened condition of the appendix prevent any thing more being done, these measures will be found quite sufficient, if pure carbolic acid be applied to the mucous membrane on the stump so as to disinfect this. If the appendix, where cut through, be healthy or only thickened, one or other of the following more elaborate methods may be adopted. Two small flaps of peritoneal and muscular tissue being raised from the upper and under surface of the appendix, a little above the spot where it is to be cut through,* the mucous coat which then projects is tied with silk and severed, the two little flaps being drawn over the stump and sutured with fine catgut. I have used this method in two cases and it makes a very neat stump, but a thickened condition of the appendix and a very sharp knife are necessary to effect this satisfactorily. Another method which gives very satisfactory results when the operation does not need rapid completion is thus given by Dr. Fowler (*Ann. of Surg.*, vol. i. 1894, p. 348). A temporary ligature is placed round the appendix close to the cæcum. This is not tied but simply twisted until it closes the lumen sufficiently. This temporary ligature should be long enough to be grasped by pressure-forceps, which, by their weight, when dropped outside the abdomen, will prevent the untwisting of the ligature. A second ligature is applied and tied about half an inch in front of the first. A circular incision is then made in the space between the two ligatures so as to raise a cuff-like flap of the serous and sub-serous tissues. Within this reflected flap and as nearly as possible on the same level as the temporary ligature the appendix is tied with sterilised catgut which is cut short, the appendix amputated and nitric acid applied to any mucous membrane projecting from the stump. The temporary ligature having been removed the cuff-like flap is drawn over the face of the stump, and the latter, grasped in a pair of dissecting forceps is inverted into the cæcum so as to form a furrow or depression in the latter. The edges of this depression are then sutured over the stump of the appendix.† However the appendix is removed, when

* Or a cuff-like flap may be turned back as in a circular amputation.

† Mr. Barker (*Brit. Med. Journ.*, vol. i. 1895, p. 863) recommends the following method of double ligature as being simple and rapid. It is based on the fact that when the appendix is much thickened the mucous and sub-mucous coats can after circular division of the other coats be drawn out in an unbroken tube. The mesentery having been first transfixed, tied, and severed near the cæcum, the serous and muscular coats are divided circularly about three-quarters of an inch from the cæcum. The mucous and sub-mucous tube is now drawn out, and the outer

it is severed, any escaping contents must be received on gauze. &c. The meso-appendix must always be looked to, its artery properly secured, and if its stump can be drawn over that of the appendix, this will suffice in place of any more elaborate methods. Where the surgeon is in doubt about dispensing with drainage, and closing his wound entirely, the extent and severity of any infective process, and the completeness with which he has been able to disinfect the deeper parts of the wound must aid in the decision. The safest course in doubtful cases will be to leave the wound partly open, provisional sutures being inserted and left loose, and gauze strips employed (*vide supra*).

We next have to consider *the different conditions met with when, on opening the peritonæum, an abscess is present*, and the best means of dealing with them.

In those cases, and they form a large number, where the abscess is made additionally safe by becoming adherent to the abdominal wall, the surgeon will have a hint given him of the presence of this condition by the oozing and inflammatory matting of the deeper layers as he divides them.

We will suppose a more difficult case with no such tendency of the abscess to come forward through the abdominal wall. When the peritonæum is carefully divided the structure which most probably first presents itself will be the omentum matted down into the iliac fossa, perhaps adherent to the ileum, cæcum or the neighbourhood of Poupart's ligament. This being secured and divided in several pieces a mass is found which consists of small intestine, cæcum and appendix. Before this is dealt with it must be shut off from the rest of the peritonæal cavity by tampons of iodoform gauze wrung out of 1 in 20 carbolic-acid lotion. The operator then scrutinises the mass, and endeavours to find any evidence of a longitudinal band which will denote the cæcum and may lead to the appendix itself. If he find one or more coils of intestine he gently separates one from the other, or turns the whole mass upwards carefully from the fossa, and while doing so probably gives rise to an escape of pus.* This is carefully mopped

coats having been stripped back, as in a circular amputation, towards the cæcum, the above-mentioned tube is tied close to its juncture with the cæcum with fine silk and cut off. It at once retracts, the outer tube is drawn down over it and tied with fine silk or gut.

* Perhaps the site of this may be recognised by a yellowish sloughing spot. Thus, in a patient sent to me by Dr. Dakin, after tying off a sheet of omentum, a large mass appeared in which I could not differentiate large or small intestine. No appendix could be seen or felt. On gently turning up the whole mass a sloughing spot was seen below, from which a blunt-pointed director gave vent to two drachms of pus. Pressure on the mass was now made, but no more pus escaped, and as no stercolith could be detected, a gauze drain being inserted down to the spot, I closed the rest of the wound by three layers of buried sutures (*vide infra*). A good recovery followed, and the patient has been able again to take briefs at assizes, but it is only nine months since the operation.

away as fast as it escapes. If large in amount the patient must be turned over on to his right side to expedite the flow and preserve the peritoneal cavity from contamination. The greater part of the pus having escaped, the question of irrigation arises. It will probably be safer to trust to drying out the cavity with gauze on holders, and gently running in iodoform emulsion. Anything like forcible syringing or irrigation is to be condemned for fear of washing infective particles where they might set up a general peritonitis. The cavity being cleansed the appendix (if possible) is removed by one of the methods given at p. 798. A transfixion of the base of the mesentery with an aneurism-needle carrying a loop of silk, one-half of which is thrown round the appendix and the other round the mesentery, the ends cut short and the appendix and its mesentery amputated just beyond the ligature will probably be found sufficient. Any projection of the mucous coat should be disinfected (p. 798). When the appendix cannot be quickly found no prolonged search should be made for it, and where it is found, but forms part of the abscess wall, it should be left alone, for fear of doing far more harm than good. Whether it be removed or no, if a perforation be present, search should be made for a possible stercolith, as a fistula may follow for some time if one of these be left behind.

In those cases where pus has been present, the wound should only be closed in part, a drainage-tube being inserted and iodoform gauze strips packed around it, to replace the soiled ones which were inserted at first. Provisional sutures should be inserted in the margin of the part not closed, to be tightened up as the tampons are removed.

The more reason that the operator has to be doubtful whether he has entirely cleansed the abscess cavity, the more thoroughly will he use such antiseptics as iodoform, iodoform emulsion, solution of zinc chloride, or, in cases that are very foul or accompanied by oozing, turpentine.

Any gauze tampons which have been used in the treatment of this or the next variety around the drainage-tube, or packed amongst loops of intestine where these have been in contact with pus, or subjected to much exposure or handling, should be removed, in part at least, on the first or second day. The object of the gauze is to keep surfaces free from sources of sepsis, to immobilise damaged parts and to drain by capillary attraction. But the longer it is left the more firmly does it adhere, and the more does its removal cause pain and bleeding. In some cases it will be judicious to administer gas when the bulk of the gauze is removed.

Operative Interference in Suppurative Peritonitis.

—The perforation here is due either to the acuteness of an infective process, to the pressure of a stercolith, to both combined, or to the rupture of a collection of pus. It is important to bear in mind these, the chief causes, as the evidence, both before and later, may vary somewhat. Thus, suppurative peritonitis may come on without the preliminary warning of a swelling (p. 795), as when the

peritonitis is not preceded by an abscess. Again, when the rupture of an abscess is the cause of the peritonitis the characteristic symptoms of collapse will be more marked.

The warning* symptoms will be chiefly those given at p. 796: viz., a case often severe at first and progressively so, severe pain, marked local tenderness, rigidity, perhaps a swelling, tympanites spreading from the iliac fossa, early immobility of the diaphragm and abdomen, obstinate vomiting, early and persistently rapid pulse, and a high temperature.† Later on, marked distension, absence of any peristaltic movement, constant vomiting of the effortless regurgitation type, a pulse increasing in quickness and failing in strength, the drawn-up knees and the *facies Hippocratica*—all these are time-honoured evidence which will show that while surgical interference may be right, it will probably be futile.‡

Operation.—The question here arises whether one or two incisions are to be made—viz., one over the iliac fossa and a median one as well. If there is well-marked evidence of general suppurative peritonitis, and if the patient's condition will only admit of one incision, probably the median will be best, as giving more general access to the peritonæal sac, and, perhaps, admitting also, by free retraction, of getting at the vicinity of the appendix proper. The median incision has also the advantage of enabling the surgeon to see how far the peritonitis is general, for it must be remembered that irrigation, especially when carried out vigorously and thoroughly, may easily carry infective products to parts hitherto uncontaminated. But when the case admits of it the iliac region should be explored as well. Even if general the peritonitis is likely to be severer here, septic products more abundant, and prolonged drainage more required.

The median incision is made, the edges widely retracted and the extent of the infection made out. If any region appears to be free this should be shut off as far as may be by tampons of iodoform gauze, or by suturing the omentum to the cut edge of the parietal peritonæum of that side. The pus present is then got rid of by swabbing out with sterilised gauze or iodoform gauze wrung out of carbolic acid lotion; adherent coils are separated, most carefully

* Dr. D. B. Lees' cases (*Clin. Soc. Trans.*, vol. xxv. p. 135) show that a perforation communicating with the peritonæal sac, as long as this is shut off, does not give rise to collapse, and that the pain, tenderness, &c., may be so comparatively slight as to make it appear that operative interference is hardly justifiable. Yet under these circumstances the delay of a few hours may be fatal.

† Too much attention is not to be paid to these. In Dr. Fowler's words (*Ann. of Surgery*, vol. i. 1894, p. 153), "A lowering temperature and a lessening pulse-rate are not inconsistent with impending ulceration, perforation of the appendix into an unprotected peritonæal cavity, complete gangrene of the organ, or rupture of an appendicular abscess into the cavity of the peritonæum."

‡ Dr. Gerster (*Ann. of Surgery*, vol. ii. 1893, p. 46) shows that in a few of these cases a stage has been reached in which recovery can only take place by letting them alone. Thus, in two cases of his, which were at death's door, perforation into the rectum occurred without any of the shock which an anæsthetic and operation would have caused, and recovery followed. If a bi-manual examination reveals a fluctuating mass in the pelvis, an incision should be made here.

drawn out and cleansed. The question of irrigation will now arise. When the pus is evidently diffused, when it is very foul, when the adhesions are few or absent, this may be employed. Boiled water or saline solution are preferable to lotions of mercury perchloride and carbolic acid, being less irritating. Whether irrigation or sponging out is trusted to the condition of the lumbar pouches and the pelvis must be sedulously attended to. The last named must be drained by a glass tube.*

The iliac fossa is next examined, the appendix found, if possible, and removed according to the directions given at p. 798. Disinfection (p. 817) is again carried out by swabbing with gauze, or irrigation, and the part drained. In either case, if no special apparatus is at hand, the irrigating fluid can be conducted within the abdomen by a sterilised drainage-tube, arranged from a basin, like an ordinary syphon. Attached to this should be a glass-tube, or a new, large catheter, sterilised. The elevation of the tubing will regulate the force of the stream. To aid in the removal of pus, the intestines are gently moved to and fro by the fingers, and this may further be promoted by gently squeezing and kneading the abdominal walls. If there be time, any excess of fluid left after irrigation, is removed by sponges on forceps. Drainage is provided from both openings, as above directed, provisional sutures being inserted. In some cases it may give an additional chance to drain from one loin by counter-puncture. After irrigation a glass tube must always be placed in Douglas's pouch (p. 818).

Operative Interference in Relapsing Appendicitis.

—In this subject the profession owes its lead and the most instructive of its information to Mr. Treves, who first proposed the removal of the appendix, during a quiescent period, in 1877, in a paper read before the Medico-Chirurgical Society.†

One or more of the following *conditions*, given by Mr. Treves, will be accepted by all as *justifying operation*: (1) The attacks have been very numerous. (2) They are increasing in frequency. (3) The last has been so severe as to place the patient's life in considerable danger. (4) The constant relapses have reduced the patient to the condition of a chronic invalid, and rendered him unfit to follow any occupation. (5) Owing to the persistence of certain local symptoms during the quiescent period, there is a probability that a collection of pus exists in or about the appendix.

Operation.—This is performed on the same lines as those given at p. 796. The details will vary with each case.

* Of these I prefer one known as Chamberlen's. It has one end rounded, suitable for resting against inflamed peritoneal surfaces, and the other drawn out and narrowed, so that a drainage-tube for sucking out is readily fastened on. But where concrete masses of fine pus and lymph are present, the large open end of a Keith's tube is preferable.

† The most valuable contributions of this surgeon are his "Treatment of Typhlitis," 1888 and 1891: *Brit. Med. Journ.*, vol. i. 1893, p. 835; vol. i. 1895, p. 517. In America, Dr. H. Mynter, following on the lines of the late Dr. G. Buck, was one of the earliest to advocate operative steps in certain cases of appendicitis, especially those accompanied by perforation (*Buffalo Med. Journ.*, 1879, p. 122).

"Some of the cases have been most trifling. On the other hand, in two instances I failed to remove the appendix after very persisting attempts. It is impossible to predict beforehand the features of the operation. The attacks may have been violent and numerous, and the removal of the diseased process nevertheless prove to be a mere trifle. On the contrary, some of the most difficult operations I have met with have been cases in which I had hoped, from the history of the attacks, to have encountered no complications" (Treves).

The skin, having been carefully cleansed (p. 657), and an oblique incision made, bisecting McBurney's line* about $1\frac{1}{2}$ inches above the anterior superior spine, the layers of the abdominal wall are incised till the peritonæum is reached. The greatest care must now be exercised, as the cæcum may be adherent to the peritonæum. If any difficulty is experienced the incision should be prolonged outwards, until it is certain that the peritonæal sac is opened. Any omentum that is present, adherent or thickened, should be removed. The appendix is now identified. This may be easy or difficult, from the structure being embedded in adhesions, lying under a cæcum itself fixed by adhesions, or tied down in one of the loculi which Mr. Lockwood has described. When it is found, its removal may be rendered difficult or impossible by the density of its adhesions, or by the important structures which these have implicated. Thus, Mr. Treves, in the 32 cases which he has published, has found it adherent to the ureter, internal iliac artery, bladder, ileum. In the 13 cases on which I have operated, I was fortunate in only having to deal with adhesions to the cæcum, both to the cæcum and one of Mr. Lockwood's loculi, and posterior aspect of Poupart's ligament.

The following, one of the two cases in which Mr. Treves found it impossible to remove the appendix, gives a good idea of the difficulties which may be present. "For a considerable time I was unable to demonstrate the abdominal cavity, owing to the adhesions. The cæcum was completely buried in a dense mass of adhesions, and here was hidden no doubt the appendix. I was not disposed to undertake the serious risk of opening up this area, especially as the adhesions obliterated both the ureter and the iliac veins, structures in no little risk of being wounded in these operations." The patient remained free from attacks up to the date of the case being published, six months after the operation.

When the area in which the surgeon is going to find or separate the appendix is defined, it should be shut off with iodoform gauze tampons or flat sponges. Where possible, adhesions should be cut with blunt-pointed scissors; where soft, or where the surgeon is in doubt as to their nature, they must be very carefully torn through with a fine-pointed blunt dissector. Where this separation of adhesions has opened the cæcum or ileum, these must be carefully closed with Lembert's sutures (p. 827). Where it is quite impossible to separate the appendix from such structures as the bladder, iliac vessels, ileum, &c., Mr. Treves recommends division, of the

* This may have to be modified according to the position of the swelling.

appendix as near to the cæcum as is safe, and then paring down the part adherent to the dangerous viscus until it is reduced to a mere disc. The actual removal of the appendix is carried out by one of the different methods given at p. 798. When any area has been unavoidably denuded of its peritoneal covering the edges of this must as far as possible be drawn together, or an omental flap, applied. If this be impossible iodoform should be rubbed in, and if the part is intestine and weakened, iodoform strips should be used to shut it off and drain it, as directed at p. 800. Drainage with a glass tube should always be employed where there is much oozing, or where the parts have been much disturbed.

To minimise as far as possible the risk of hernia, especially in young subjects with an active life before them, the wound in the abdominal wall should be carefully sutured. The peritonæum, internal oblique and transversalis, the aponeurosis of the external oblique, each of these three layers should be united with a separate row of buried sutures of chromic gut or silk, and then the skin with salmon-gut. If drainage has been employed, provisional sutures should be inserted.

Complications of Appendicitis.—Owing to the frequency of the disease and of operations for it, it will be well to bear in mind the chief complications which may accompany the severer cases, and operations for their relief. A mere enumeration must suffice. (1) Intestinal obstruction. This may be due (*a*) to paralysis of the intestines from septic peritonitis; (*b*) from adhesions about the appendix; (*c*) from its becoming adherent to some piece of intestine, mesentery, &c., and so incarcerating and strangling a loop of bowel. (2) Fistula.* This may be (*a*) mucous, or (*b*), faecal. It may arise from incomplete closure of the appendix, the leaving behind a stercolith, or to giving way of the cæcum or ileum. (3) Hepatic abscess. (4) Empyema, or (5) Purulent pericarditis. Dr. Fowler shows (*loc. supra cit.*) that pus in the liver will tend to involve the diaphragm and so bring about the two last conditions. I should have thought a simpler explanation was a collection burrowing upwards along the psoas. I have had one such case of right-sided empyema. The patient, aged fifty-three, made a good, though very slow, recovery, chiefly due to the devoted attention of his dresser, Mr. Anderson. (6) Suppuration in the loin, and about the kidney. (7) Suppuration in the pelvis. An exceptionally long appendix may dip into the pelvis and bring about the above. A case of this kind is given by Fowler. It was successfully treated by abdominal section. (8) Phlebitis of iliac veins. Fowler gives a case in which the appendicitis being gangrenous brought about ulceration and fatal hæmorrhage. (9) Appendicitis in a hernial sac. Fowler mentions a case reported

* Treves' "Surgical Treatment of Typhlitis," p. 45. Mr. Southam has published (*Lancet*, vol. ii. 1892, p. 835) a case successfully treated by short-circuiting the intestine. Senn's plates were used.

by Dr. Rand of Brooklyn in which an irreducible femoral hernia became the site of inflammation due to an inflamed appendix which it contained. Mr. Treves met with a case in which the appendix, the seat of recurrent trouble, occupied an inguinal sac. (10) Communication with the rectum, bladder, or vagina. (11) Septicæmia. This may supervene, as on one of the last-mentioned complications, quite apart from suppurative peritonitis. (12) Abscess in the abdominal wall, causing most extensive burrowing. (13) Stitch sinus. (14) Ventral hernia.

PERFORATION OF GASTRIC ULCER.*

The successful treatment of these most fatal lesions depends upon early operation.† The operation includes itself: i. Finding the ulcer; ii. Successfully closing it; iii. Efficiently cleansing and draining the peritoneal sac, headings which will be taken separately.

Early Operation.—This should be performed as soon as possible after the accident, delay only leading to the additional escape of septic material, especially if the patient has been moved about. Another urgent reason for early operation is the fact that the later the operation is deferred, the more difficult it is, and the less the patient able to bear the necessarily prolonged interference. Again, the longer the delay, the greater is the tendency to the formation of masses of lymph which may conceal the ulcer (p. 813), mat viscera together, and so form culture-pools for bacteria, and hamper the attempts at cleansing the peritoneum.

While the surgeon will be unwilling to interfere during the period of collapse which follows on the perforation, he should utilise this time in making the needful preparations.

i. Finding the Ulcer.—It seems clear that while ulcers occur most frequently on the posterior surface, it is those which are on the anterior surface which are most liable to perforate. Thus, Mr. Barling found that out of thirty-one cases which had been operated upon, the perforation in twenty-two was on the anterior surface; posterior perforations occurring in five cases‡. They are more frequently nearer the lesser than the greater curvature, and the cardia than the pylorus. This last fact is one of much practical importance, as the cardia is a relatively fixed point, and the nearer an ulcer is to this end, the greater is the difficulty in suturing it.

Operation.—The parts having been fitly cleansed (p. 657), and every precaution taken against shock, an incision 4 to 5 inches

* This is placed here instead of under the Operations on the Stomach, first, because, like a perforated vermiform appendix, it is such a dangerous source of peritonitis; secondly, because it calls for the same treatment as the less common duodenal ulcer.

† Operative interference here was first suggested by Mr. Dobson of Bristol (*Bristol Med. Chir. Journ.*, 1883). My readers should refer to very helpful papers by Mr. A. Pearce Gould (*Brit. Med. Journ.*, vol. ii. 1894, p. 859) and Mr. Barling (*ibid.*, vol. i. 1895, 1314).

‡ Mr. Gould thinks that in several of the twenty-two anterior perforations the lesions might have been as correctly described as being on the lesser curvature.

§ A hot-water table, water-bed, and hot bottles should be provided, the patient's limbs bandaged in cotton-wool, the head kept low, ether given, an enema of port wine administered, and injections of strychnine and the necessaries for saline infusion should be at hand.

long is made in the middle line* from the tip of the xiphoid cartilage to the umbilicus. When the peritonæum is opened an escape of gas is not uncommon;† sometimes of fluid, consisting partly of the last meal taken,‡ and partly of serous oozing from the irritation of the peritonæum.

If there is no such escape the outlook is so far more favourable as it may be hoped that as yet the effusion is slight, and limited to part only of the peritoneal sac. If this be so, though it is uncommon, the surgeon should shut off the lower part of this sac as far as possible with gauze tampons or flat sponges before he disturbs the stomach and its surroundings.

Finding the Perforation.—This varies very much in difficulty. Sometimes the eye detects it at once when the stomach is drawn down (by gently pulling on the omentum, if need be) and the edges of the wound retracted. At other times the exploring finger soon feels it or the area of induration which forms the base of the ulcer.§ In other cases finding the ulcer is beset with the greatest difficulty, or, owing to the hurried search which alone is possible from the state of the patient, is quite impossible. In a difficult case help may be obtained by tracing the direction in which the congestion of the stomach appears to be increasing, by watching the direction from which any flow that may be present is coming, or, acting on a suggestion which has been made by injecting air through an œsophageal tube, that the escaping bubbles may lead to the ulcer. If a careful search over the anterior surface of the stomach fail, the liver should be raised by an assistant, and the lesser curvature examined with a good light. Adherent lymph or adhesions between the stomach and liver may mark the site of the perforation, and require gentle separation before it is revealed. The perforation itself may be extremely small, and thus easily hidden by any fold of the stomach, still more readily by lymph and adhesions.

Mr. Dunn's case (*loc. infra cit.*) well shows how difficulty here is to be met:

On separating the adhesions which fixed the liver to the abdominal wall, a quantity of opalescent fluid escaped. The liver was then pulled upwards and

* I advise this as giving better means of cleaning thoroughly all the peritoneal sac. Some have preferred an oblique one under the left ribs, one in the left linea semilunaris, or one to the left of the linea alba.

† If it is a late case as in one I mention (p. 810), the tympanites and distended intestines may be most embarrassing. In one published by Dr. Anson (*Lancet*, vol. i. 1893, p. 469), the distension all subsided after a rush of odourless gas when the abdomen was opened.

‡ The interval that has elapsed is most important. Thus, in a successful case published by Dr. Walter of Reading (*Lancet*, vol. i. 1895, p. 484) five hours had elapsed. So, too, in a case of Dr. W. Hall's (*Brit. Med. Journ.*, vol. i. 1892, p. 64) which recovered without operation after very severe peritonitis, the interval was four hours.

§ The perforation itself may present itself as a depression in the midst of the induration.

the anterior wall of the stomach pushed backwards, and now it was that some brownish fluid like weak coffee, containing gas bubbles and one or two small masses of coagulated milk, escaped. It welled up from a considerable depth, at the left of the incision, and was found, on subsequent examination, to be strongly acid, and to contain a little albumen. Several more adhesions were broken down, but still no perforation could be seen, and it was only when the left margin of the wound was stretched outwards to the utmost, whilst steady traction was made upon the stomach towards the right, that the hole in this viscus became visible.

At this stage, or a little later, in order to facilitate the suturing, it may be necessary to divide the left rectus, in order to get more room. Save for weakening the abdominal wall this step is a light one, as long as the intestines are not distended. If distension is present it is a serious complication, as it facilitates very much the escape of the intestines.

ii. **Closure of the Perforation.**—It has been suggested, before this is done, that the stomach should be emptied and washed out. If the perforation has been quickly found, if the patient's condition is good, and if the stomach can be got well outside the wound, emptying by gentle squeezing will be beneficial, by preventing vomiting, and thus a strain on the sutures. So, too, with regard to washing out the viscus, if a drainage-tube can be readily inserted through the perforation. But the small size of the external opening will often prevent this, and with regard both to emptying and washing out the stomach, it is certain that in neither case will the advantages gained counterbalance the loss of time, that should have been better spent later on, in thoroughly washing out the peritonæal cavity.

With regard to *excising the ulcer*, which has been recommended, the same conditions and objections apply. Much extra time will be consumed, there may be a good deal of additional hæmorrhage, and the perforation converted into a large gap requiring numerous sutures to close it (Swain, *Lancet*, vol. ii. 1894, p. 22). In this case much difficulty was met in inverting the pouting mucous coat. Moreover, the successful cases treated by suture without excision show that this step is not needful. If the perforation is spilling its contents when seen, a finger or sponge in a holder should be placed upon it, or a silk suture passed across its centre so as to prevent further escape. The perforation being shut off with iodoform gauze tampons it is next carefully closed with Lembert's sutures of sterilised silk.* One row of these will suffice if inserted with the following precautions: They should begin and end well beyond the extremities of the perforation (Fig. 182). They should take up the coats of the stomach as far as, but not beyond, the sub-mucous layer. They should be inserted sufficiently far from the margins of the perforation to ensure sufficient inversion of the serous surfaces when the sutures are tightened,

* The passage of these may be facilitated by the use of two guide-stitches of medium-sized silk, passed a full inch from the edges of the perforation as used by Mr. Gould in his case.

and this inversion may be aided by a probe or director. All the sutures should be inserted before any are tied. If any cut out as they are fastened, fresh ones must be re-inserted at a sufficient distance from the margins of the perforation to give a firm hold, and a second set must be employed where the union is certainly weak.

Whenever it is feasible the suturing should be performed with the viscus outside the wound, this part of the stomach resting on hot carbolised towels or tampons of iodoform gauze.* When it is not possible to bring the stomach outside, the difficulties are greatly increased, especially if the perforation be near the cardia, a more fixed part. Here drawing up the margin of the ribs and liver, pulling down the stomach, or dividing the left rectus may be of service.

Where it is impossible to close a perforation with sutures, one of the two following courses should be followed: (1) a closely fitting drainage-tube should be passed into the perforation † to draw off all remaining food and secretion, and then the space between the stomach and the abdominal wall should be closed all around the tube with strips of iodoform gauze, so as to promote adhesions. (2) A less satisfactory plan is to stitch the margins of the perforation to the edges of the wound in the abdominal wall and treat it as a gastric fistula, the rest of the wound being firmly closed round it. Mr. Bennett successfully used a plug of omentum. (*Lancet*, vol. i., 1896, p. 310.)

So far I have spoken of *ulcers on the anterior surface of the stomach*.

The rarer but much less accessible ones on the posterior surface must now be referred to. As is well known, while gastric ulcers are much more frequently met with on this surface, these rarely perforate, owing to the tendency for adhesions to form between this surface of the stomach and the pancreas. If the evidence of perforation is strong and nothing can be found on the anterior surface or lesser curvature, the surgeon can examine the posterior wall by (a) carefully tearing through the lesser omentum and inverting the anterior wall; the posterior one comes into view through the hole made in the lesser omentum; ‡ (b) by tearing through the great omentum, (c) by passing the finger through the foramen of Winslow.§

* Whenever during an abdominal section it is necessary to keep viscera outside, it should be the duty of one assistant to see that their temperature is maintained and that their surroundings are aseptic only, and it should be the duty of a separate nurse to help in this.

† Mr. Paul of Liverpool finding that the ulcer that had given way was in an almost inaccessible position and that it was not possible to suture the perforation perfectly, ligatured in a glass tube. This was removed about two weeks later, and in another fortnight the fistula closed.

‡ Mr. J. R. Morrison of Newcastle adopted this plan (*Brit. Med. Journ.*, vol. ii. 1894, p. 864). The patient survived till the ninth day, and at the autopsy the peritonitis was limited to the pelvis.

§ In a case successfully operated on by Mr. J. Jowers of Brighton (*Lancet*, vol. i. 1895, p. 544) it is stated that no perforation being found on the anterior aspect, the omentum was pushed over and the posterior surface similarly examined. An indurated patch could be felt here, though the posterior layer of the omentum prevented actual contact. The incision having been enlarged to the left, the

iii. **Cleansing of the Peritonæal Sac.**—Though most stress has been laid upon the point of efficient suturing of the perforation, there is no doubt that this one is quite as important. The fluid used should not be an irritating one, such as *lot. hydr. perch.* or carbolic acid, but boiled water or saline infusion, *e.g.*, *sod. chlor.* 5j — Oj of boiled water at a temperature of $105^{\circ} - 110^{\circ}$. If no irrigator is at hand a glass tube or the end of an œsophagus tube attached to india-rubber tubing (all having been sterilised) and arranged as a syphon will answer very well. Failing this, a clean Higginson's syringe will suffice, if some one else pumps in the fluid so as to set free both the surgeon's hands for the delivery and distribution of the fluid. The cleansing must be systematic, persevering, and thorough. The whole cavity must be gone over in a regular way, and there is no better method than that given by Dr. MacLaren who has operated in three cases, in one with success (*Brit. Med. Journ.* vol. ii. 1894):

"The plan I take is to begin with the neighbourhood of the rupture, wash it well; then starting from this as a centre, to make the nozzle follow the course of the colon, first towards the cæcum, specially cleaning out below the liver; secondly, starting again from the stomach to follow the great bowel to the rectum. In this latter course the lumbar and pelvic hollows should receive special care. Finally, the douche is directed among the folds of the mesenteric attachments of the small intestines. I have repeatedly noticed here, when all seemed clear, that a fresh turn of the instrument would empty some unsuspected pocket."

Cleansing the peritonæum with sponges or gauze mops has been advocated by some. I can find no case recorded as recovering in which an effusion throughout the peritonæal sac was removed, and successfully, by cleansing without irrigation. (See also p. 816, *The Treatment of Suppurative Peritonitis*). If, however, there be time, cleaning out the bulk of the fluid, food, and thick masses of lymph with sponges or gauze mops will aid the efficiency of the irrigation afterwards.*

Cleansing of the peritonæal sac by irrigation should be performed in every case.

Exceptions to this rule must be of the very rarest, as when the last meal has been just before the perforation,† an extremely rare contingency, and when on the

omentum was torn through and the lesser peritoneal sac opened. With considerable trouble the perforation was brought into view by pushing over the stomach wall bit by bit.

* The irrigation may be rendered more effective by the adoption of a plan used by Mr. Morse of Norwich in his successful case (*Trans. Med. Chir. Soc.*, vol. lxxvii. p. 189). To facilitate the return of the water, a long glass tube was passed in by the side of the irrigator, and by moving these two together Mr. Morse went systematically over the abdomen until the water returned from every point quite clear. As much as seventeen pints of water ($F. 105^{\circ}$) were used.

† Thus, in Dr. Walter's case (*loc. supra cit.*), five hours had elapsed between the last meal and the perforation, only gas escaped when the peritoneal sac was opened. There was no general peritonitis, no stomach contents were found, and there were no adhesions. The sponges brought up some pieces of lymph from the region of the spleen. The peritoneal sac was washed out with weak boracic-acid lotion.

fullest search the surgeon can satisfy himself that the general peritoneal sac uncontaminated. Though it might be useless, it should not be dispensed with even in a case like the following (Silcock, *Clin. Soc. Trans.*, 1895, p. 214). When the peritoneum was opened some bubbles of gas and clear neutral fluid escaped, and a small perforation was found on the anterior wall and sutured. It was not thought necessary to wash out the abdomen because what little discharge had collected escaped when the peritoneum was opened, and there were no signs of a general peritonitis. The sub-peritoneal lymphatic space had probably become infected, for continuous lines and patches of exudation involved the peritoneum and the sub-peritoneal tissues covering the liver. It was clearly impossible to get rid of infection here, unless the parts had been freely scraped or by the application of strong escharotic antiseptics. The patient died of septicæmia and sub-phrenic abscess on the fifteenth day.

Before closing the abdominal wound the question of drainage will arise. This should be employed in most cases, and the more thoroughly when there have been found traces of gastric contents where the surgeon has any doubt as to his having removed all the septic fluid), or where any irritating fluids, such as lot. hydr. perch. or carbolic acid, have been employed. As the worst of the effusion will probably have been near the perforation, and as some fluid is almost certain to be left in the pelvis, two tubes should be employed, one brought out through the wound above with its deeper end placed either very close to the sutured perforation, or in some pocket such as that between the colon and liver, where fluid is seen to re-collect. Another tube should be passed into the pelvis and brought out by a small incision above the pubes. The length and size of openings in these tubes has been referred to at p. 802.

Rectal feeding must be employed for at least forty-eight hours, nothing being given during this time save sips of tepid water if possible. It will be well to watch these cases for a long time after. Thus, Mr. Silcock reports of a case treated successfully by drainage, the ulcer not being found; the patient "has suffered since from impaired locomotion of the stomach, and has been from time to time under treatment as an out- or in-patient."

Causes of Failure.—In every new operation especially it is well to bear these in mind. The chief are: (1) Peritonitis existing before and not removed by the operation. This has been the most frequent cause of death. It was so in two cases in which I operated. Both were under the care of Dr. Newton Pitt.

In the first the symptoms of shock and peritonitis were distinctly sub-acute and slightly marked. My colleague however was sure of his diagnosis, and when the abdomen was opened an open ulcer was easily seen on the anterior surface, from which a greyish liquid was continuously gushing. On bringing the perforation outside the abdomen the opening was felt to be surrounded by a large callous base. Death took place from peritonitis forty-eight hours later; at the autopsy the ulcer was found firmly sutured. In the second case operation was refused at first when urged upon the patient, and it was not until the third day, when the abdomen was greatly distended, tympanitic and motionless, that the patient and her friends, seeing how hopeless the case was getting, gave their consent. When the abdomen was opened the stomach itself was greatly distended. The peritoneal sac, especially at its upper part under the liver, between this and colon, spleen and kidneys, was filled with purulent fluid, in which the more solid part of the last

meal taken, Scotch broth, could be seen floating. All the viscera seen were thickly scattered with thick yellowish flaky lymph. This was especially present, together with numerous soft adhesions, between the lesser curvature and the liver. Had I broken down and searched amongst these I should have found the ulcer,* but the anterior surface being sound and the stomach greatly distended, I examined the duodenum and found, as I thought, a minute perforation, a softened spot on the anterior and inner part of the first portion, into which a probe passed. This I sutured, and sponged, and washed out the peritoneal sac. The patient was in a most critical state at the time of the operation, and sank thirty-eight hours after. At the autopsy a perforation was found on the lesser curvature.

(2) Shock of the operation and anæsthetic. (3) Abscess between the stomach and liver causing septicæmia or leading to empyema.

The treatment must be efficient drainage; an incision being made in front, in the middle line or over any epigastric prominence. Drainage should also be afforded behind by resection of one or more ribs (*Lancet*, vol. i. 1893, p. 145), or a glass drainage tube be employed as in a case of Dr. Ewart's and Mr. Bennett's (*Lancet*, vol. ii. 1894, p. 1147).

(4) A second perforation. When the ulcer is very large another weakened spot may give way,† probably from softening set up by the local inflammation due to the suturing.

Mr. Gould (*Brit. Med. Journ.*, vol. ii. 1894, p. 861) mentions a case of Mr. Pepper's in which a perforation had been sutured. For three days the patient did well, when she suddenly became collapsed and quickly died. The autopsy showed that the perforation which had been sutured was in the front part of an ulcer the size of a crown-piece, the line of suture being perfect and water-tight, but that a second perforation had occurred at its posterior part.

PERFORATING DUODENAL ULCER.‡

Very little need be added here to the account just given. This form of ulcer occurs most frequently in men, and perforation may cause symptoms indistinguishable from those of acute intestinal obstruction (Lockwood). The only hope is that the case may be seen early and evidence obtained that the pain felt was at first epigastric and any early tenderness referred to the right epigastrium.

Operation.—Where no such information is at hand, the surgeon will make a free median incision with its centre at the umbilicus; the appendix, Fallopian tubes, &c., will be found healthy: perhaps an escape of gas will take place when the peritoneal sac is opened, and it may be noticed that the fluid which is the cause of the peritonitis is not fæcal in character.§ If the operation be early the fluid may give an acid reaction, if time has not elapsed for this to be neutralised by the secondary peritoneal effusion.

* No surgeon should leave these unexplored, in the hope of a natural cure. This, if accomplished, will very likely be so at the cost of a sub-phrenic abscess and septicæmia. See also the remarks above.

† In Mr. Dunn's case (*Clin. Soc. Trans.*, 1895) intense pain and vomiting occurring on the thirteenth day made it possible that some adhesions had given way. The abdomen was again explored and nothing found. The patient made a good recovery.

‡ My readers will find cases recorded by Mr. Lockwood (*Lancet*, vol. ii. 1894, p. 969; Mr. Eve, *ibid.*, p. 1092, and Mr. Shield, *ibid.*, vol. i. 1895, p. 1169).

§ That this is not always so is shown by Mr. Eve's case. The fluid is described as "sero-purulent with a fæcal odour" and as "purulent fæcal fluid."

The ulcer is most commonly met with on the anterior aspect of the first piece and is thus accessible. Sometimes it is on the posterior surface, as in one of Mr Lockwood's cases in which the autopsy showed that it would not have been seen at an abdominal exploration.* In the further details and essentials of the operation the account already fully given for the treatment of the much more frequently perforating gastric ulcer must be closely followed.

PERFORATION OF TYPHOID ULCER.

Owing to the unfavourable state of the patient operation has been here much less frequently resorted to. Both the local and general conditions are much against success; while the perforation is most often in the ileum, it may be in the jejunum, appendix or colon. It is often multiple. Perforation may take place when the patient is convalescent after a mild attack, and has gone back to work (Cayley). Surgeons want an authoritative opinion as to which of these terrible cases there is any hope of doing good to by interference, and especially as to whether perforation must mean a fatal extravasation. We are not here dealing with young adults who have often just eaten heartily. We should all agree with Dr. Cayley (*loc. supra cit.*), that discovery is not possible after much extravasation. Another authority, Dr. Goodall, has spoken the following weighty words: "It was often extremely difficult to say when perforation had taken place, and if the operator delayed until the fact was made evident by the onset of peritonitis the case was by that time hopeless. Looking back at the last twelve cases which he had seen of perforation during typhoid fever he was sure that in not one would surgical intervention have had the slightest chance of success. As many cases of perforation recovered under medical treatment alone, this made hesitation necessary before deciding to interfere" (*Lancet*, vol. i. 1894, p. 673).

Operation.—This must be carried out on the same lines as those described for perforation of a gastric ulcer. The stage of collapse having passed off and every precaution having been taken against shock, an incision is made in the middle line† beginning a little above the pubes and continued upwards sufficiently high above the umbilicus. When the peritoneum is opened the cæcum must be taken as a landmark to the lower end of the ileum.‡ Enlarged mesenteric glands or zones of intense inflammation may also be guides to the perforation. As soon as this is found the coil should be safely brought outside the abdomen, packed around with hot sterilised towels or gauze tampons, and the perforation closed according to the general and local conditions while the surgeon has to face. Thus (1) if the perforation is single, small and the surrounding intestine in a condition to hold sutures, the perforation should be closed with sterilised silk, a continuous suture first, and then Lembert's sutures if there be time. (2) If it is clear that the tissues are too friable to hold sutures, either the perforation must be excised, a plan adopted by Mr. Sutton, or (3) the perforation must be brought a little outside the abdominal wound and fixed by sutures which take up healthy bowel. Later on this artificial anus can be closed. (4) Where

* So, too, in a specimen brought by Dr. Pye-Smith before the Pathological Society (*Lancet*, vol. ii. 1893, p. 1443), it is distinctly stated that the ulcer could not have been reached by operation.

† Or one in the right linea semilunaris may be chosen. That in the middle line perhaps gives best opportunities for systematic irrigation.

‡ In an instructive case, nearly successful, as the patient lived until the sixth day after the operation, under the care of Dr. Cayley and Mr. Bland Sutton (*Clin. Soc. Trans.*, vol. xxvii. p. 137), the loop with the perforation in it was found in the pelvis.

the mischief is very extensive * part of the intestine may be removed and the ends united by a Murphy's button, or both brought outside and Paul's tubes placed in them, *vide infra*. Owing to the condition of the patient any such steps as sutures will be quite out of the question. Perhaps the plan that will give most successes will be to keep the perforation outside while the peritoneal sac is being thoroughly irrigated† and, a day or two later, to deal with it by suture, or resection. Lücke, whose fatal case of resection I have referred to, advises that this step should be performed in two sittings, the artificial anus only made first, and closed the next day.

Thompson (*loc. supra cit.*), besides his own two cases, gives a list of twenty-one cases, but some of these are most equivocal. Four recoveries are given, but of these only one (Van Hook, *Phil. Med. News*, vol. lix. p. 591) is an undoubted case of recovery after operation for a perforated typhoid ulcer. While this sheet is passing through the press, I hear that Mr. Bowlby has had a completely successful case at St. Bartholomew's Hospital.

ABDOMINAL SECTION IN PERITONITIS USUALLY SEPTIC OR TUBERCULAR.

In dealing operatively with a case of peritonitis the surgeon may find the following **classifications** useful:

(A.) **Cause.**‡—i. *Peritonitis set up by mischief in the intestinal tract, whether accompanied by perforation or not.* Instances of this group would be hernia, appendicitis, intestinal obstruction, malignant disease, a caseating mesenteric gland, enteritis, duodenal ulcer, typhoid perforation. ii. *Peritonitis set up by mischief in other viscera than the intestine, whether accompanied by a perforation or not, e.g.,* a suppurating ovarian cyst, twisted ovarian pedicle, salpingitis, septic metritis, puerperal peritonitis,§ ruptured bladder, suppurating gall-bladder

* In a case recorded by Dr. Thomson of Texas (*Med. Chron.*, Sept. 1895) the cæcum was so disorganised as to require removal. The two ends were brought outside. Death took place eight hours later. Another case showing how terribly altered the tissues may be with which we have to deal is mentioned by Mr. H. Allingham (*Lancet*, vol. i. 1894, p. 675). Here the ileum was adherent to the sigmoid flexure and tore to pieces when touched. Suturing of the perforation being impossible, it was fixed in the wound. Death occurred twenty-four hours later. Lücke of Strasburg (*Deut. Zeit. f. Chir.*, Bd. xxv. Hft. 1, 2, December, 1886) excised a wedge-shaped piece of the intestine. The operation took nearly two hours and the patient never rallied, dying nineteen hours later.

† This must be systematic and complete (p. 817) as the extravasated material here is most septic. In a case skilfully operated on within two hours of the perforation (Parkin, *Lancet*, vol. i. 1895, p. 193), the peritonitis still proved fatal. The extravasation being fæcal, the tubes used for drainage both of the pelvis and the iliac fossa should have large open ends.

‡ It is plain, I think, from such carefully reported cases as one by Dr. S. West (*Clin. Soc. Trans.*, vol. xix, p. 36), that cases of idiopathic purulent peritonitis do, very occasionally, occur. Dr. Hilton Fagge (*Guy's Hosp. Rep.*, 1875), stated that in an experience of twenty years he had only met with two cases of acute peritonitis in which no local cause could be found.

§ I fear the pathology and the published cases in which abdominal section have been resorted to here are alike most unfavourable. If the surgeon interfere early, he will probably only find a congested condition of the peritonæum. If he wait till tympanites and purulent effusion be present his efforts at relief will, I fear, be equally futile in the face of this severe general septic infection.

or spleen. iii. *Traumatic peritonitis from the effects of contusion, gunshot or other injuries* (p. 892). iv. *Tubercular peritonitis*. This last will be taken by itself. (B.) **Extent and progress.**—In the first three classes, which are always septic, the two distinct varieties of Mikulicz (*Centr. j. Chir.*, No. 29, 1889) which, though they run into each other, form two types should always be distinguished in practice, viz., (1) *The diffuse septic peritonitis*, in which a large portion of the peritoneal surface is quickly infected, and, no adhesions being formed, the infection spreads rapidly. (2) *Progressive peritonitis*, here the peritonæum is only affected at first in the neighbourhood of the cause. This focus is at first shut off by adhesions, but as the process gradually spreads, larger or smaller quantities of purulent exudation are encapsuled between the glued viscera. Mikulicz thinks that the treatment in the two must be different. In the first the whole peritonæum must be disinfected as far as possible. In the second not the peritonæum in its whole extent, but each inter-peritoneal focus must be opened separately.

Operation.—We will take here a case where the septic peritonitis is diffused, where the surgeon is in doubt as to its cause, and where he is met by that combination of ominous conditions which confront us in these cases, viz., peritonitis and effusion, a septic condition, distended paralysed intestines, and exhaustion from pain, vomiting, &c.

In no cases is the need of meeting shock more imperatively needed, viz., bandaging the limbs in cotton wool, a hot-water mattress, or hot bottles to feet and trunk, ether or the A. C. E. mixture, and only enough anæsthetic to keep the patient quiet and to prevent the shock of pain, a plentiful supply of hot water which has been boiled, care that no instruments or towels may come in contact with the patient's vitals, either cold,* or just out of irritating chemical solutions.

The skin having been well cleansed, the abdomen is opened by a sufficiently free incision in the middle line.† Now, and throughout the operation, every manipulation is to be carried out as quickly as possible. Slow operation means failure (Lockwood).‡

When the peritonæum is opened the next steps will depend upon the history of the case, and the fluid or gas which escape. If either of the latter be fæcal, the ileo-fæcal region is first examined, owing to the frequency with which the chief causes of inflammatory or mechanical obstruction are found here. If none are found, and the cæcum is distended, it is clear that the obstruction is in the large intestine or is inflammatory. To settle this

* A temperature of 105° will be sufficient for instruments, towels, &c., and, as I have said before, if any viscus has to be withdrawn outside the abdomen it should be the duty of one assistant to keep its temperature from falling, and of one more to keep him supplied with towels or tampons previously carbolised and wrung out of sufficiently hot water.

† This, down to the peritonæum, is to be made as quickly as possible, no time being lost in necessarily hitting off the linea alba exactly, and where more room is wanted, or where the abdominal walls are rigid the incision must be at once prolonged to the left of, and above, the umbilicus.

‡ *Med. Chir. Trans.*, vol. xxviii. Here will be found one of those rare cases of diffuse septic peritonitis saved by surgery. The cause was an unexplained perforation of the ileum.

point the sigmoid flexure is next examined. If it be distended, and if there be no obstruction in the rectum, a point previously ascertained, the case is clearly not one of mechanical obstruction (Lockwood). The odourless gas and acid fluid mixed with recently taken food which escapes from a gastric perforation, the brownish acid fluid (occasionally faecal) which may come from a similar lesion in the duodenum have been alluded to above. Gelatinous-looking fluid probably indicates a ruptured cyst. Bloody ascitic fluid ordinarily points to hæmorrhage or a malignant growth.

In other cases, the history, the age, or the presence of enlarged mesenteric glands may point to the rupture of an abscess due to a caseating gland, or a rounded body in the pelvis to a suppurating ovary.

We will next suppose a perforation closed, or some other cause removed, and now we have before us how best to deal with the conditions remaining, viz., the distended paralysed intestines, the removal of the septic fluid, and the question of drainage.

I have, already, under the treatment of acute intestinal obstruction, dealt upon the necessity of emptying the intestines before the abdomen is closed,* otherwise death is almost certain, from the continued toxæmia from the persisting passage of organisms, of which the *bacillus coli communis* is only one, and from the interference with the action of the lungs and heart by the pushed-up diaphragm.

The emptying of the intestines may be effected by multiple punctures, (this being only safe if gas alone is present), with a fine trocar, such as a Southey's, the puncture being made obliquely. If the coats are softened and the puncture is not effaced by some of them gliding over the others, a drop of intestinal contents will very likely ooze out and continue to leak. This spot should be at once closed by a suture, with a very fine round needle, otherwise matters will only be made worse. Where fluids are also present, incising one or two of the most distended coils is preferable to the use of a large trocar, which, however sharp, is liable to leave lacerated edges. The incisions should be about $\frac{3}{4}$ inch long and made in the long axis of the bowel, on the aspect opposite to the mesentery. As I have before said (p. 783), even after boldly incising, the amount of relief secured is often disappointing. This is due, in part, as Mr. Greig Smith has pointed out, to the acute flexures in which the distended intestines are held by the mesentery, in part, also, to the easily paralysed condition of the bowel. The opening being brought well outside, and safely kept there by an assistant, the surgeon, partly by tracing up and squeezing adjacent coils, partly by elevating one end and lowering the

* Travers, as Mr. Treves (*loc. supra cit.*) calls him, "the father of intestinal surgery," long ago insisted upon the need of this, and urged that if the intestines were distended, the operation was incomplete without this step. More recently Mr. Greig Smith and Mr. Lockwood have drawn attention to the need of this.

other of each distended loop aids the evacuation. As each coil is emptied it is cleansed and returned, but any incised loop is kept outside till the last, then closed with Lembert's sutures and dropped back.

Where any perforation is present it may be simply enlarged for drainage, a plan adopted by Mr. Lockwood in his successful cases. Where a patch is gangrenous and there is no time for resection, a Paul's tube may be inserted, a plan, adopted in a case of acute intestinal obstruction due to bands, with great distension of the small intestines, in a case of Dr. Perry's at Guy's Hospital, in 1895. The lad recovered with a faecal fistula, which was subsequently closed (p. 878).

The next step is the cleansing of the peritoneal sac. The surgeon must here remember the distinction (p. 814) made by Mikulicz, between a *septic peritonitis, already diffuse and general, or one shut off here and there by adhesions, and so spreading more slowly. In the cases where the peritonitis tends to be of a plastic character*, where the intestines are matted here and there with lymph of varying tenacity, other parts of the peritoneal space appearing healthy; the surgeon has to face the following dilemma. If he separate the adhesions he will set up troublesome bleeding, he may break down important repair, and he may infect peritonæum still uncontaminated. On the other hand, by not disturbing the adhesions, he may leave pools of septic fluid, and he may miss, just when it is within his reach, the chance of closing some perforation, or in removing some other cause of all the trouble. I have mentioned such an instance at p. 811, in the treatment of perforated gastric ulcer.

Mr. Treves' authoritative opinion in these cases inclines (*loc. supra cit.*; *Brit. Med. Journ.* vol. i. 1894, p. 519) to "doing no more than is necessary, or as little as is obvious. A clump of adherent intestines will often cover and protect a perforation, and the ubiquitous lymph will many times close such an opening with more speed and security than are provided by any system of suturing.* . . . The main purpose of the operation is to allow a noxious exudation to escape, and, if possible, to free the peritonæum of the cause of its trouble. . . . If the operator can rid the serous cavity of the effects of the perforation, he may very often leave the breach itself to be dealt with by natural means."

Mr. Treves goes on to say that irrigation is certainly not suited to this class of case—peritonitis partially localised by adhesion—gauze sponges forming here the best means of cleaning the peritonæum. Drainage is seldom required, and when employed is best provided for by strips of iodoform gauze passed among the coils to the necessary depth. The same authority recommends in

* Mr. Treves refers to Kaiser's statistics (*Deutsch. Arch. f. Klin. Med.*, 1876). Here thirty cases of operation for perforative peritonitis were collected with eleven recoveries. In five of these the exact site of the perforation was not ascertained.

this form of perforation, a liberal dusting of the serous membrane with iodoform, save in the case of children.

My own opinion with regard to these cases of septic peritonitis partially localised by adhesion is, that the chief point is drainage, especially where the fluid is purulent and fetid. Drainage must here be secured at all hazards, both by gauze drains and tubes from in front, and by incisions behind. Repeated operations may be required.

It is in cases of *diffuse septic peritonitis* that the question of the best means of cleansing the peritonæal sac will especially arise. I have already spoken of these at p. 809, in the treatment of perforating gastric ulcer.

Some of the objections to irrigation have there been referred to. They are: (1) That there is a risk of spreading the septic condition; (2) That irrigation is less efficient than sponging;* (3) that it may lead, especially if chemical irritants—*e.g.*, carbolic acid, &c.—are used, to much subsequent effusion of serum, and, thus, to a pabulum for any septic organisms which may remain; (4) that it seriously diminishes the resisting power of the peritonæum (Treves, *loc. supra cit.*).

On the other hand, if the employment of sponges be very prolonged and very vigorous,† there is risk of much shock at the time, and of copious irritative effusion later.

Where the fluid is healthy, so to speak, *e.g.*, blood, hydatid, bile, &c., where it is recent and not wide-spread, and where the operation-area can be safely circumscribed, cleansing of the peritonæal sac can be best and most safely accomplished by the use of sponges or gauze-sponges, soaked for some time in (1 in 20) carbolic acid lotion, and then wrung out of boiled water.

* Mr. Treves quotes the experiments of Reichel (*Comptes Rendus*, 1880, p. 1220) as strongly supporting this objection. Reichel introduced fæcal matter into a dog's peritonæum, and having closed the wound, reopened it after a while, and employed irrigation in some cases, sponging in others. He found neither of them entirely successful, but was convinced that sponging was the more efficient of the two. Even when from ten to fifteen litres of fluid were used, a quantity of infective matter was found to have been left behind. He irrigated the healthy peritonæum in certain animals with boiled water. All the animals so treated recovered, but some were ill for a long time, and some had urgent dyspnœa. These simple irrigations produced a blood-stained exudation in the peritonæal sac, and many hæmorrhages into the intestinal peritonæum. Reichel is clearly somewhat sceptical concerning the value of so called surgical treatment of septic peritonitis, save in the localised form, and it must be remembered that his experiments were performed on strong, healthy animals.

† In speaking of the need of great care in the use of sponges in the peritonæal sac, Mr. Treves writes (*loc. supra cit.*, p. 52c), "It is possible that the cleansing and drying of the peritonæal sac may be attained at too great a cost, and that the 'toilet of the peritonæum' may become a very uncouth and barbaric process." Further on, speaking of the use of strong antiseptics and countless sponges, he writes, "If the infinitely tender character of the peritonæum be borne in mind, this toilet, as sometimes practised, is comparable to the removal of a foreign body from the eye by means of a scrubbing brush and plenty of washing soda."

Where the fluid is very foul, copiously discharged and widely spread, irrigation with one of the solutions mentioned at p. 309. introduced at blood heat, is preferable. In Mr. Treves' words this should be "introduced at low pressure, but in a wide stream. The irrigating tube is of soft rubber, and may have a diameter of three quarters of an inch. The tube itself is introduced into the belly cavity. The flow through it can be regulated by a clip. Any form of rigid nozzle is to be most strongly condemned. The solution should flow gently into the abdomen. The peritonæal cavity is to be flooded, and not to be scoured out with a violent stream of water, which hisses and rushes from a vulcanite nozzle like a miniature fire-hose. When the belly cavity is quite full of fluid, the surgeon's hand, which is already in position, is moved to and fro amongst the intestines with great gentleness. By a movement of the hand, and pressure here and there, the fluid overflows from the wound, and is replaced by the steady stream. As the water which escapes becomes clear, the upper end of the table is raised so that the shoulders are much elevated, and then little has to be done but to wash out the most dependent parts, including especially the pelvis.* Finally, what fluid remains in the pelvis is removed with sponges, and a sponge on a holder is retained in the bottom of the pelvis during the introduction of the stitches, and only withdrawn at the last moment."† It is important that the temperature be constant, the abdomen not overdistended, and that the stream be not directed against the diaphragm. If these precautions be neglected alarming dyspnœa may take place (Reichel). Polaillon has noticed three cases of cessation of respiration in the human subject during irrigation (Treves). The most suitable fluids are the saline infusion already advised or boiled water, or dilute solutions of boric or salicylic acid, or of iodine about ℥j—Oij.

Drainage.—Where the septic fluid was foul, where it is certain that all the irrigating fluid has not been withdrawn, this should be employed. First as to *site*. As, at an autopsy, fluid is always found in the pelvis, and sometimes only there, a glass drainage-tube (p. 802) should always be placed in the pelvis‡ so that fluid can be sucked out. Other glass tubes, or india-rubber ones of appropriate size and properly fenestrated, should be placed in those areas

* From first to last the whole peritonæal sac and its contents must be gone over as methodically as possible. For ensuring this the excellent directions of Dr. Maclaren of Carlisle (p. 809) should be remembered.

† There are some who hold that irrigation fluid may safely be left behind, as the peritonæum has well-known powers of absorption. Such too often forget that here we are dealing with a damaged sac, not the healthy one of experimenters.

‡ Mr. Treves writes as follows on this point: "There seems little to commend the employment of a glass tube passed into the fundus of Douglas's pouch. I have ceased to use this appliance." This advice, I think, though it is not so stated, should refer only to cases where the peritonæal sac has been thoroughly dried, or where the degree of sepsis was but slight.

which have been most disturbed (Treves), or where especially septic collections were found, or where bleeding may be going on. These must be brought out in front, or, by counter-puncture, laterally or behind. Provisional sutures must always be inserted. The tubes may usually be removed in forty-eight hours. If the discharge be foul that is sucked out of any of them, it is best to trust to frequent withdrawing of the fluid. Irrigation by the tube may produce fatal collapse, and it is difficult to make certain of the return of the fluid sent in.

Gauze drains are made of strips of iodoform gauze about one inch and a half wide and containing five or six layers.* They are largely used by Continental surgeons.† The objection to this form of drainage is the risk of poisoning, the difficulty and pain in removing them, and the greatly increased risk of hernia. As it is certain, however, that the autopsies in septic peritonitis show, most constantly, inadequate drainage, I am of opinion that the above means of drainage should be much more extensively employed, until replaced by treatment more satisfactory. Where the peritonæal surface has been unavoidably damaged, as in the separation of adhesions, the treatment must vary according to the severity of the lesion. In slight cases iodoform may be rubbed in, in severer ones an omental graft employed, or tamponnading with iodoform gauze. The latter is the most generally applicable, and that with the least delay.

After-treatment.—To two points only here will my space allow me to refer. They are the most important. One, the need of persevering persistence in combating shock according to the directions given at p. 805. The other, the value of aperients. If tympanites and distension supervene or continue, the paralysed, thinned intestinal walls probably allow of the passage through of bacteria or their products, which are taken up from the peritonæal sac, thus giving rise to a toxic state. The passage of the long tube, the introduction of enemata containing ol. ricini ℥ij, ol. terebinth. ℥ss, or mag. sulph. ℥ij: if the patient can swallow, the administration of calomel gr. v. and a Seidlitz powder, alternately every three hours, may be very useful. I would refer my younger readers to an excellent account of the "After-treatment of Abdominal Cases," by Dr. C. Martin, *Birmingham Med. Rev.*, 1892, 1893. Where the bowel has been emptied by incision, the above will not be required. Finally, by the firm application of towel-pads the onset of tympanites may sometimes be prevented.

* Jalaguier (*Bull. de Mém. de la Soc. de Chir.* 1891, p. 800) is quoted by Mr. Treves as having passed these strands in all directions amongst the intestinal coils from the diaphragm to the pelvis with a good result.

† The Mikulicz drain or tampon is used to check dangerous abdominal hæmorrhage, to close extensive breaches in the peritonæum, or to shut off structures which are septic. It is a sheet of iodoform gauze placed *in situ*, as an open bag, and stuffed with strips of the same material. These are removed piece by piece after the first forty-eight hours; a few days later, when empty, the bag itself is removed.

TUBERCULAR PERITONITIS.

This form of peritonitis should be placed by itself from the operative point of view, as it differs from all the others which we have been considering, in being by no means always septic, and for this reason, probably, being curative by other means. How far the claim recently made, especially by Continental surgeons, that the mortality may be materially diminished by operative interference, is just one, must remain undecided until a larger number of cases, unsuccessful as well as successful, are recorded.*

The following *varieties* are of much practical importance to the surgeon:

A. *The Ascitic*.—Here the inflamed peritoneal sac and its contents are studded as far as can be seen, with hosts of grey “sago grain” granulations, tending to become confluent. Caseation is absent or only present in a very early stage. The fluid is rarely sero-purulent. Adhesions are absent or insignificant. The fluid here may be localised and encysted. The ascitic form may come on very insidiously and is not uncommonly the subject of a mistake in diagnosis. B. *The Caseating and Purulent*.—Here caseation is always present; the amount of pus varies. Usually this is abundant, and is too often encysted, imperfectly, in many collections. More rarely the caseation is dry, unattended with effusion, the intestines being matted together by adhesions which are themselves infiltrated and caseating. If the adhesions are separated hosts of small loculi present themselves, with scanty fluid, usually purulent. The caseating is the variety which we see so typically in wasted children with hectic, vomiting, and diarrhoea.† C. *The Fibrous*.—This is the rarest, but a favourable variety. The bacilli are probably scanty. Caseation is absent, and any fluid present not purulent and scanty.

In this form and the second, if such parts as the omentum and mesentery are densely infiltrated, a new growth may be closely simulated.

Question of Operation in Tubercular Peritonitis.—I am of opinion that in the claim made of late years, that the mortality of tubercular peritonitis has been diminished by operation, cases of the ascitic variety which are most favourable for operation have not been sufficiently kept apart from the purulent in which the outlook is very different. Again, it is useless to publish accounts of operations for the ascitic variety at once, as recurrence may easily occur. The following **indications** appear to me to justify operative interference: (1) Failure of medical treatment, the patient losing ground, the fluid persisting, &c. In hospital cases where sea-side air, &c., cannot be obtained, resort to operation is earlier justifiable; (2) where tapping has failed, as I believe it always will; (3) where suppuration is probable; (4) where any especially grave symptom is present, as pain and wasting; (5) where intestinal obstruction seems threatening.

Where the tubercular disease of other organs, such as the lung, is present, abdominal section will be contra-indicated, but not necessarily so if other serous or synovial cavities are involved.

It is evident that the more the disease approximates to the “fibrous” variety (*vide supra*), the less is operative interference indicated.

* Dr. H. P. Hawkins, a careful and critical writer, is of opinion, from the examination of 100 cases consecutively treated at St. Thomas's Hospital, that there is but little difference in the mortality whether operation is resorted to or not. Such slight difference as does occur is in favour of operation (*St. Thomas's Hosp. Rep.*, 1892).

† It is in this form that faecal fistula may occur from adhesion of a softened coil of intestine to the abdominal wall.

Operation.—There is little that need be added to the full account already given under the heading of Diffuse Septic Peritonitis, p. 814.

It is most important to draw off all the fluid whether this be serous and sweet, or purulent and septic. We do not know how abdominal section destroys the bacilli. The withdrawal of a vital pabulum, a vital moisture, the improved absorption, are probably fatal to the life of the bacillus; * whilst the patient's chances are of course improved, as in drainage of other purulent collections, by the relief of pain, tension, hectic, &c.

Where the fluid is ascitic, or if purulent not foul, irrigation will not be required. Drainage should certainly be dispensed with in the "ascitic" variety. When the fluid is purulent, and especially if it be foul, drainage should be employed according to the directions given at p. 818.

ENTEROSTOMY.—FORMATION OF AN ARTIFICIAL ANUS IN THE SMALL AND LARGE INTESTINE.

This subject has, in part, been already considered under Colotomy, I now allude to it again to aid my readers when they have to face the following indications: **A. Chiefly referring to the Small Intestine and the Acute Intestinal Obstruction.**—*E.g.* (1) When the surgeon cannot detect the site of obstruction, or where he finds it, but cannot remove it—*e.g.*, a complicated band—nor resect the intestine owing to the local or general conditions—under these circumstances he may be driven to open the small intestine as near the cæcum as possible, utilising his incision in the middle line.† (2) When the surgeon decides, owing to the patient's condition, not to perform an ordinary abdominal section, but to relieve the distension, &c., by opening the bowel above the obstruction, usually by what is called Nélaton's operation. Such operations are only palliative, and are only to be made use of when the adoption of other and more desirable courses is impossible, or when the surgeon feels sure he can open the small intestine low down.‡ It has been urged by those who have recommended such operations—*e.g.*, Nélaton, 1840—that some obstructions relieve themselves if a temporary outlet has emptied the accumulation above. This may be true of a very small number of cases—*e.g.*, volvuli

* Dr. Cameron, of Huddersfield, suggests that the fluid contains toxic chemical products resulting from the growth of the tubercle bacilli; that this poisonous fluid is absorbed, and exerts a deteriorating influence upon the tissues and the general health, the establishment of the disease in other organs being thus favoured (R. L. Knaggs, *Clin. Soc. Trans.* vol. xxi. p. 37). This careful paper relates one of the earlier English cases successfully treated by abdominal section.

† An objection to this course is given at p. 688.

‡ If the opening be high up in the small intestine, death from inanition is certain.

which have not gone too far, and loops which are incarcerated rather than strangulated. Another point urged in favour of this operation is that it involves much less shock and disturbance of the abdominal contents. This last is true. But, from what I have seen, this operation usually fails, by leaving irrecoverable mischief behind in the very cases to which it is best suited—viz., acute obstruction where the lesion cannot be found, or where it cannot be dealt with, or is beyond recovery. Even if it succeed it is at the cost of great and lasting inconvenience. Owing to the liquid state of the contents, control is very much less, and the rawness and eczematous state of the tissues adjacent to the opening is productive of the greatest discomfort.

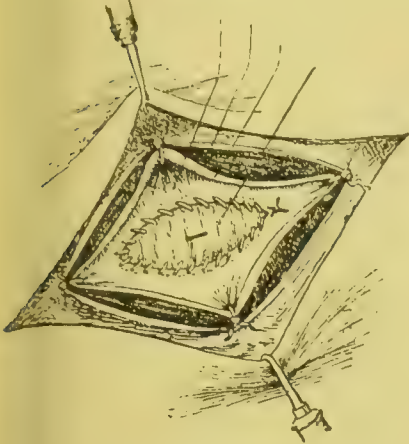
Finally, it is probable that in many cases enterostomy will be replaced by intestinal anastomosis or short circuiting (*q.v.*).

Formation of an Artificial Anus in the Middle Line (Fig. 18c).—The contents of the peritonæal sac having been shut off by gauze tampons, and sponges, the surgeon makes an artificial anus by one of the following ways: A loop of intestine, as near the obstruction as possible, being chosen by its distension, congestion, &c., it is brought outside, and as much of the median incision as is feasible is safely closed with sutures. Those sutures which have to be placed nearest the intestine should not be tied, but kept clamped with Spencer Wells' forceps, so that the surgeon may easily draw out or replace some of the intestine as he requires. If on withdrawing the loop of intestine to be opened it is possible to empty a knuckle of it into adjacent parts, and then shut off this with one of the varieties of clamps (p. 858), it will greatly facilitate the remaining steps. The intestine is now fixed either by some form of rod and sutures, or by sutures alone. In either case, if there be time, the parietal peritonæum may be sutured here and there, by points of fine silk passed with round needles, to the peritonæal coat of the intestine so as to shut off the general peritonæal sac.* Then a piece of suitable bougie, glass rod, &c., which has been boiled, is passed through the mesentery by Mr. Reeve's plan (p. 705), avoiding any vessels, so as to keep the loop well out of the abdomen. The clamps are then taken off, and if too much bowel has been withdrawn some is returned, the parietal wound now closely sutured up to the projecting gut, and a few sutures placed between the intestine and the margin of the wound. These must not enter the lumen of the bowel. Finally there must be no twisting of the gut as it is brought out. If the rod is used, care must be taken that too much of the gut is not prolapsed, a point rather difficult to secure by this method. The smaller the prolapsus consistent with safety—i.e., non-contamination of the peritonæal sac—the less the irritation and bleeding from friction of the clothes, &c., in the future.

* Great care must be taken not to perforate the lumen of the bowel. This is much facilitated by first emptying and clamping the coil.

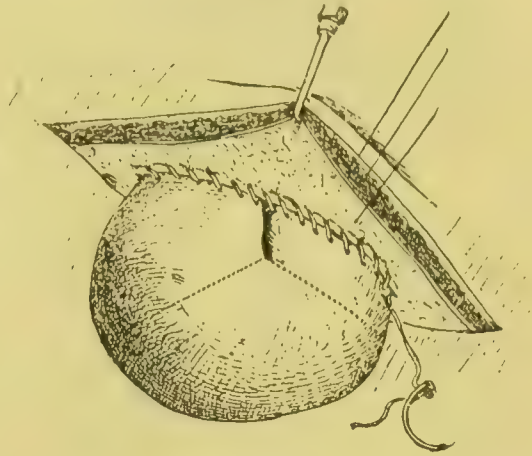
and the smaller the opening to be closed by any subsequent operation if this prove feasible. If sutures alone are used, most of the above steps are the same, but extra care must be taken in closing the parietal wound, so as to support the intestine which is to form the artificial anus, and additional sutures must be passed between the edges of the wound in the parietes and the bowel. If this be distended much caution will be required lest the lumen

FIG. 179.



Fæcal fistula. The parietal and intestinal peritonæum have been united by a continuous suture (Kocher). This figure should be contrasted with Fig. 180, which shows an artificial anus. Here there is no prolapsus and no spur, this opening being intended for temporary purposes.

FIG. 180.



Formation of an artificial anus. A continuous suture has been used (Kocher). It is evident that there will be a good spur and plenty of prolapsus; much of this will be cut away later on (p. 704). This, which is intended for a permanent opening, should be contrasted with Fig. 179, which shows a fæcal fistula only.

is opened and the wound infected. The employment of the continuous suture is shown in Fig. 180.

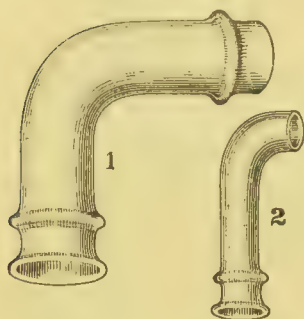
Opening the Bowel.—If it be possible a few hours should be allowed to elapse.* But if immediate relief is required one of the following methods may be adopted. The whole of the wound, save where the opening is to be made, is covered with iodoform and the sutured edges may be sealed with collodion and iodoform. (1) The bowel may be opened by a trocar and cannula which have been passed through a piece of thin india-rubber sheeting (Cripps) so that the fluid fæces do not flood the wound, &c. As soon as the cessation of the flow makes it feasible, the numerous small sutures between the intestine and the edges of the skin may be reinforced by others, which can now be more easily inserted. Another very useful precaution is to insert a temporary suture into

* If this delay is possible, a guiding-stitch should be inserted (not entering the lumen of the bowel) at the point where the opening will be made. This renders easy what otherwise, owing to the rapid alterations in the surface of the bowel and landmarks, may prove very difficult

the intestine, close to where the opening is to be made, so that by pulling on this the surgeon can keep the bowel forwards and the flow away from the wound. If the trocar and cannula are not forthcoming, the patient having been brought to the edge of the table and partly turned on to one side, the wound is protected with the above precautions, and the intestine opened by a small incision, the fæces as they escape being quickly washed away from the wound by a gentle stream of boiled water. A third method, and the one I prefer, is to make use of a Paul's tube (Fig. 181, 2). I have already referred to the use of the larger size in the performance of colotomy (p. 706).

The glass tubes are made in two sizes. That used for the colon or rectum (p. 1094) (Fig. 181, 1) has been improved in shape by Messrs.

FIG. 181.



Wright & Co., of New Bond Street, who have succeeded in bending it at the proper angle, which avoids all strain on the bowel. It measures 5 inches in length by 1 in diameter, has a double rim at the bowel end and a single rim at the distal end, and is bent at a right angle. The tube for the small intestine (Fig. 181, 2) is as light as is consistent with sufficient strength. It measures $2\frac{1}{2}$ inches by $\frac{1}{2}$ an inch, and is bent at a right angle at the distal end.* Fæces from the large tube are received into a jaconet bag

containing wood wool, or other absorbent material, except the first rush in cases of obstruction, which is best received in a basin. To the small one an india-rubber tube is attached, which conveys the liquid fæces of the small intestine into a bottle beneath an antiseptic fluid (Paul, *Liverpool Med. Chir. Journ.*, July, 1892). Two objections have been made to the use of these tubes. One, that it is difficult to insert the tube without the risk of letting some fæces escape over the wound. This is certainly true when the intestine is distended and the fæces fluid. If, however, the loop to be opened is emptied into adjacent bowel, and temporarily clamped if possible (p. 822), the introduction of the tube is greatly simplified; otherwise, the operator may safely trust to drawing out the bowel as much as possible and isolating it with gauze. The other objection is that the silk ligature may cut its way through too quickly, especially if the bowel is much congested. Thus, the tube may be loose in two or three days; but it not unfrequently remains for a week firmly adherent, partly because some of the circulation becomes re-established beyond the ligature, and partly owing to the copious

* In either case, the end with the double rim is introduced into a small incision made in a loop of intestine, drawn out if possible and safely shut off with an aseptic gauze-packing. The end thus inserted is then securely tied in with a silk ligature of sufficient stoutness. While this is being tied, an assistant with two pairs of dissecting forceps should keep the edges of the opening in the bowel well pulled up over the rim of the tube.

exudation of lymph, which covers the bowel to the very end, quite concealing the ligature (Paul). If the tube becomes loose too soon, two or three Spencer Wells' forceps should be applied to the margins of the opening in the bowel, so as to keep this forward until the parts are more firmly healed.

I have given (p. 878) a case in which, in 1895, after dividing two bands in a case of acute intestinal obstruction admitted on the fourth day, I drained the intestines by a Paul's tube tied into the worst of three gangrenous patches present. Vomiting with some tympanites continuing, I had an ounce of castor-oil given by the tube. Abundant flatus was soon passed per rectum, and recovery steadily followed. Owing to the patient's brutish behaviour—he was discovered on the point of drinking his urine, he took solid food from other patients, and five days after the operation pulled the tube out of the bowel—a faecal fistula followed, which I closed by the method given at p. 878.

Another means of relieving a distended bowel is aspiration, as advised by Mr. Greig Smith (p. 783).

Nélaton's Operation. Right Iliac or Inguinal Enterostomy.
Operation.—A horizontal incision, about 2 inches long, is made a little below the centre of a line drawn from the umbilicus to the right anterior spine, or one lower down parallel with the outer part of Poupart's ligament. The cæcum having been made out to be empty, the relation of this to the distended coils which are present in the wound should, if feasible, be made out, so that the small intestine may be opened as low down as possible (p. 822). In making the opening those details already fully given (p. 822) must be followed.

B. Conditions chiefly affecting the large Intestine and bringing about Chronic Intestinal Obstruction.—Enterostomy under these conditions has been already referred to in the account of colotomy.

Given a case in which the obstruction is somewhere in the large intestine, where, though perhaps the onset has been given as acute, the surgeon is clear from the age, history, &c., that it is really a case of acute on chronic mischief (p. 777) the following courses are open to him :

1. If the patient's condition admit of it, this is the one I prefer. An incision being made below the umbilicus, the surgeon examines first the sigmoid and then the large intestine up to the cæcum. The obstruction having been found, the surgeon must deal with it according to the patient's condition and his own surroundings. Many will prefer to close the median incision and perform a lumbar colotomy on the right or left side, according to the position of the obstruction. Others will bring, if possible, the cæcum or sigmoid or transverse colon into the median incision and establish the artificial anus there. I have stated at p. 688 my objections to thus drawing a piece of rather fixed large intestine up into the middle line. For my own part, having made out the obstruction, I should prefer to deal with it as follows, mentioning only the more usual sites (footnote, p. 688). If, as is most frequent, it is in the sigmoid, I should close the median incision, and bring out the sigmoid

with the obstruction, and keep the loop outside with a rod and sutures (p. 705), and open it at once or a little later. This would give the opportunity of resecting the affected loop later on. Another course would be to close the median incision and perform a left lumbar colotomy. If the obstruction was in the splenic flexure I should try to bring the transverse colon out into the top of the median incision prolonged upwards, and open this intestine (p. 713). If the disease is in the hepatic flexure, a right lumbar colotomy would be indicated, the median wound being closed. If lower down, the cæcum must be opened. I have pointed out at p. 712, the chief objection to this step, viz., the liquid character of the escaping fæces.

Operation.—Wherever the opening is made, the details already so fully given at pp. 706 and 823 will suffice.

UNION OF DIVIDED OR INJURED INTESTINE BY SUTURE OR OTHERWISE.

Sutures.—The number of methods devised are very numerous; most have quickly become obsolete. I shall only refer to four here, as those with which I am personally acquainted, and those which will be found, on the whole, the simplest* and the most efficient. And first as to the essentials of a good intestinal suture. The chief are:—

(1) It must be simple; one that can be rapidly introduced, and one which will effectually close the wound, and hold it secure until the parts are firmly healed. (2) In its introduction, attention must be paid to the following: (*a*) The sutures, when applied from and knotted outside, must not pass through the mucous coat, otherwise they may draw septic fluids from within the bowel to the peritonæal surface. (*b*) Each suture should pass down to, and, if possible, take up a little of the submucous coat, which is relatively strong and thick. In any case, each suture must take a sufficiently firm hold, so as not to cut out when any strain is put upon it, *e.g.*, by peristalsis or distension. (*c*) Attention must be paid to the risk of sloughing along the edges if too many sutures be used, or if they be tied with strangling tightness. (*d*) The material used must be unirritating and sufficiently durable. Fine Chinese-twist silk, thoroughly sterilised by boiling and preservation in carbolic acid lotion (1 in 20)† is the best material‡. The sutures are best introduced by the ordinary fine, round sewing-needle, the aperture of which is at once plugged by the thread which follows, while its round shaft does not wound small vessels

* Thus, I have not described the methods of Gély or Bishop, good as they are, believing the four given to be amply sufficient and more easily applied.

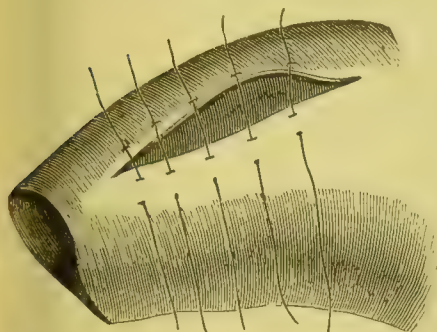
† I name this strength so as to allow of evaporation. It is somewhat too strong for a newly made wound or the surgeon's hands.

‡ Catgut should not be used. Unless very carefully prepared it is unreliable: it runs less smoothly, and makes a harder knot. Horseshair is referred to at p. 834.

like the ordinary triangular-pointed needle, which is not needed here owing to the readiness with which the intestinal coats are penetrated. Fine curved needles must be used to introduce the sutures from within (Fig. 248). It will save much time to have many needles threaded and secured on lint in carbolic acid lotion. If possible, as many should be threaded as there will be sutures, both continuous and interrupted. These should be kept apart.

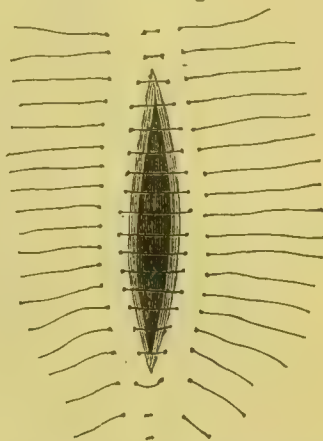
Chief varieties of Suture.—(i) **The continuous suture** (Fig. 185). This has the advantage of being very quickly applied. If the points of entrance and exit be at some little distance from the margins of the wound, the serous surface will be distinctly inverted and well apposed. The objections to it are mainly two. (a) If one part of it becomes loose, the whole is liable to become insecure.

FIG. 182.



Five sutures introduced by Lembert's method. (Mac Cormac.)

FIG. 183.



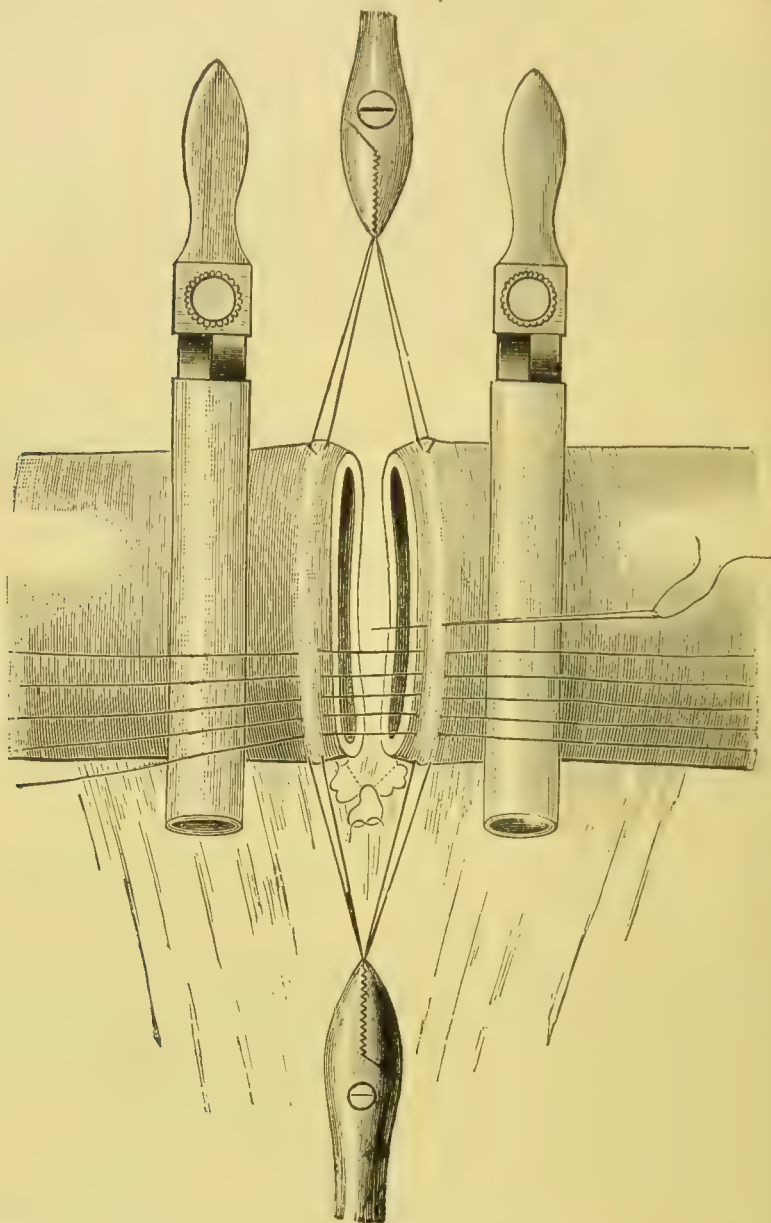
Lembert's suture, as used by Sir W. MacCormac in two successful cases of intra-peritonæal rupture of the bladder.

(b) It is difficult in tightening it to secure even tension all along the line. (c) If the bowel contract, the whole suture may become loosened, and the wound gape. Thus this suture is not to be trusted to by itself, but when used in combination* with Lembert's it is most valuable. (ii) **Lembert's suture**, (Figs. 182 to 184). The value of this depends on the fact that it fulfils in an eminent degree the condition first pointed out by the introducer, that to obtain union of an intestinal wound it is absolutely needful to bring and keep the serous surfaces in contact. Each suture should be inserted not less than $\frac{1}{3}$ inch from the cut edge, and run along deeply in the muscular or in the submucous coat; it is then made to emerge just wide of one cut edge, re-inserted just beyond the opposite edge, then at once made to travel between the coats and to emerge as before.

* Instances of combination are when the continuous suture is used from within and Lembert's from without; or when both are inserted from without, first the continuous and then the Lembert's, in closing the ends of resected intestine, between which a lateral anastomosis is about to be made.

The following points require especial attention: (1) The suture should be inserted about $\frac{1}{8}$ inch from each other.* (2) Sufficien

FIG. 184.



Suture of resected intestine. (Greig Smith.) Two sheathed Makins' clamps are in position. The mesentery has been divided close to the intestine. Its cut edge is drawn together by a purse-string stitch, which leaves free small flaps of peritonæum, which can be grafted on to the base of the line of union.† Four sutures are inserted into the opposite sides of the resected gut, and careful traction made on them by an assistant. This raises a well-defined fold along the edge of the gut, which makes the insertion of sutures more easy and regular.

* Mr. Treves puts them closer. Thus (*Operat. Surg.*, vol. ii. p. 507) he says: "The closeness of the sutures to one another must vary according to circumstances. They may usually be estimated at about ten to the inch. It will rarely be safe to apply them less closely than this."

† Other methods of dealing with the mesentery are given at p. 863, Figs. 216, 217.

inversion of the edges and contact of the serous surfaces must be secured, this being effected by entering the sutures at a sufficient distance from the edges (in Fig. 184 this is not sufficient), and by an assistant aiding the inversion by dipping in the surfaces, just before each batch of sutures is tied, with a probe. (3) Much confusion and entanglement will be saved if the sutures are tied in batches of four or six, and cut short. (4) Each needle should carry only enough silk for one or at most two sutures, otherwise there is much coiling and catching about, perhaps on surfaces not aseptic, of a long thread. Mr. Caird (*Edin. Med. Journ.*, vol. ii. 1895, p. 314) gives some hints on circular enterorrhaphy which will be found very helpful. Suture "is simplified by the introduction of three or more provisional loops, which serve to steady and approximate the edges which have to be united. The loops pass through the whole thickness of the gut. The first should be inserted at the mesenteric margin, the other two equidistant from it. Any surplus protruding mucous membrane is now snipped away,* the ends of the first and second loops are held tense, and a continuous suture is carried through the whole thickness of the gut from the first to the second loop. The second and third loops are now held tense, and the suture continues to close the second segment of the circle, after which there only remains to make the third segment of the gut tense, and the suture now travels from the third to the first loop, and completes the union of the divided intestine. Now follows over this the most important stitching in the form of a continuous Lembert suture. The provisional loops are then withdrawn, and additional Lembert sutures are inserted over the site they occupied, as well as at any weak spot which seems to require it; for example, at the mesenteric insertion. It is on the Lembert sutures we rely for secure union and safety from leakage. A careful scrutiny is now made of the junction, the gut is carefully cleansed anew with a stream of sterile salt solution and moist gauze." Before passing, as Mr. Caird advises, provisional sutures through the whole thickness of the intestine, care must be taken that the mucous membrane is clean. Bier (*Arch. f. Klin. Chir.*, xlix. 4) concludes that there is no safer or simpler method of intestinal suture than Lembert's, one row of interrupted sutures being used. In fifteen cases of resection of the intestine thus treated, two died; in neither was the fatal result due to the method employed. The time taken was from fifteen to twenty minutes. V. Bergmann, Trendelenberg, and other Continental surgeons, have borne equally important testimony to the value of this well-tried suture. A successful case of pylor-rectomy, by Dr. Adams of Glasgow, quoted at p. 918, in which a single continuous Lembert's suture (catgut) was used, may be compared with the above cases of Bier. They all show that in skilled

* The question of "snipping away superfluous mucous membrane" is again alluded to at p. 890.

hands, and when the patient's condition is fairly good, suturing alone without any especial apparatus may be safely trusted. The inversion must of course be sufficient. (iii) **The Czerny-Lembert suture.** This is only Lembert's suture reinforced by a deep row, in order to bring together accurately the margins of the mucous membrane, as well as to approximate more accurately the serous surfaces. The introduction of the first or deep row, which takes up the mucous membrane only, is shown in Fig. 248. It will be seen there that these sutures are knotted within in the lumen of the bowel; but as advised by the authors of the *American Text-book of Surgery* (2nd edit. p. 725), it is much better to make this stitch extra-peritonæal, and cut the threads short to the knot. The deep row of sutures is then buried by the Lembert sutures.

A possible objection will occur here to the minds of many. It is obvious that in this case in order to bury the first row sufficiently the Lembert stitches must be passed at an extra distance from the edges, or the vascularity of these will be impaired. This will ensure very deep inversion, additionally safe at the time; but, it seems to me, capable of producing stenosis of the bowel later on.

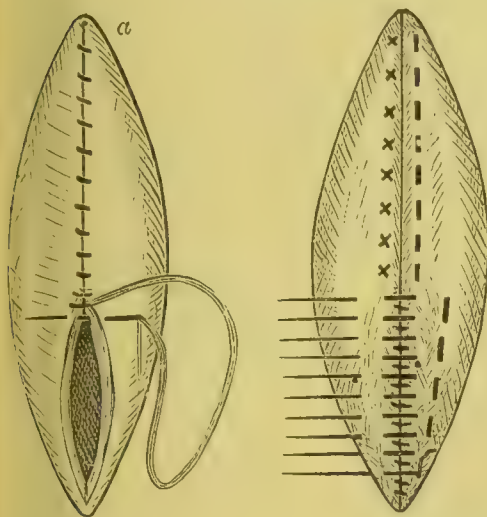
The Lembert method deserves most careful attention now, when there is an increasing tendency to replace the recently introduced plates, buttons, bobbins, &c., by a return to circular enterorrhaphy, and secondly because it was by this method, or a slight modification of it, that Mr. Lockwood, Dr. McCosh, and others, scored such striking success in their cases of resection and immediate suture of intestine for gangrene, (*vide infra*, p. 861.) Whether the Czerny-Lembert, or a continuous suture for the mucous membrane* and then a row of Lembert's stitches outside, or, thirdly, a continuous Lembert taking up just the edges, and the inversion of these effected by a second row of Lembert's sutures taking up a wider range of tissues—whichever of these should be adopted must at present remain uncertain. The continuous suture would give additional speed, and the risk of its becoming loose, if the bowel contracted, would be met by the second row.

* Hagedorn's method is a simple way of inserting the continuous internal suture. It is thus described by Mr. Kendall Franks (*Med. Chir. Trans.*, vol. lxxvi. p. 223). For suturing the mucosa a strongly curved needle (half-circle) is used: for the serous, one less curved (three-eighths of a circle). The first or mucosa suture begins at that portion of the intestine corresponding to the mesenteric attachment. The needle transfixes, beginning from within outwards, first the mucosa, then the muscularis of one side, then back again through the muscularis and mucosa of the other side of the intestine. The suture is then knotted, but the ends are not cut off. The two ends of the intestine are then sewn together with a continuous stitch until half of the circumference has been gone round, transfixing always in the same order, viz., mucosa, muscularis—muscularis, mucosa. So far the suture has been applied sewing from inside. When the centre of the convexity has been reached the order must be reversed, as we must sew from the outside. The continuous suture is now carried on round the other half of the circumference in the reversed order, viz., muscularis, mucosa—mucosa, muscularis, until the mesenteric border is again reached. The suture is now knotted to the end left free at the first knot.

But the case quoted, p. 918, of pylorotomy shows that if the inversion be adequate, a single row of Lembert's sutures will suffice. (iv) Halstead's quilt or mattress suture, (Fig. 185). The distinguished surgeon who introduced this method claims for it that (1) it is so safe that a single row of it will suffice; (2) it constricts the tissues less; (3) it tears out less readily if submitted to tension.

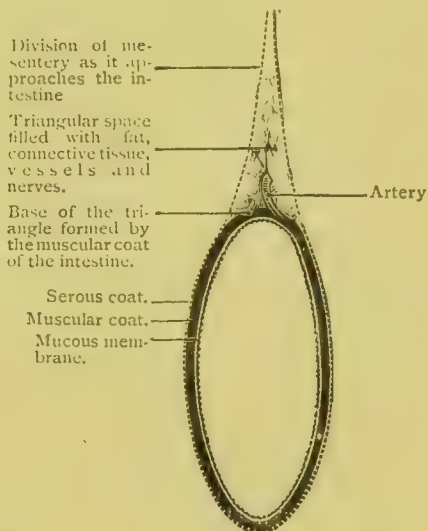
However circular enterorrhaphy be employed, close attention must be paid to these points shown in Fig. 186. The first is the triangular space which is formed by the divergence of the two layers of the mesentery at their junction with the bowel. This is occupied by fat, connective tissues, vessels, and nerves. In the

FIG. 185.



To the left the continuous suture is shown. The right-hand figure shows the continuous one inverted and buried by a row of Halstead's sutures. (Jesett.)

FIG. 186.



Section through jejunum.
(Mac Cormac.)

suturing of resected intestine this space *must* be obliterated by sutures passing from intestine to mesentery (Figs. 216 and 218). Unless the stitches thus take up the muscular as well as the mucous coat, extravasation will very likely result. The thickness of the bowel is also to be noted. The muscular layer is (Fig. 186) comparatively thick, and sutures here easy of introduction. In the ileum this coat would be much thinner and the whole tube smaller.

The **advantages** and **disadvantages** of circular enterorrhaphy are given at p. 853, where this method of uniting intestine is compared with other means, such as Murphy's button, Paul's decalcified bone-tubes, Mayo Robson's bone bobbins. As I have here said, I am of opinion that at present, for some time, the choice lies between circular enterorrhaphy alone and Mayo Robson's bobbin, with circular enterorrhaphy as well.

Rogers' Rapid Method of Performing Enterectomy without the aid of any Special Apparatus.—At the present time, while the best means of performing enterectomy are still *sub judice*, and as it will certainly have to be performed, under widely different conditions, in very different ways, the

following deserves mention on account of its simplicity.* It will be found described, *Brit. Med. Journ.*, 1896, vol. i. p. 903. The method consists in turning back the peritoneal coat of one end of the small intestine, suturing the muscular coat thus exposed to the peritoneal coat of the other end of the intestine, subsequently turning down the reflected portion of peritonæum over the first row of sutures, which are thus completely buried, and suturing the deep surface of the reflected peritonæum to the unreflected serous surface on the other end of the intestine. Thus a double sero-fibrous union is obtained which will unite both quickly and firmly. The inner sutures are passed through the muscular coat of one end, and the muscular and peritonæal coats of the other end of the bowel, while the outer sutures include the peritonæal coats only. Each row of sutures is a continuous one. The second one, which unites the peritonæum reflected off one end of the bowel over the same coat unreflected on the other, begins by uniting the triangular gap at the mesenteric junction (a most important spot, p. 831, Fig. 186) and then travels round the bowel.

This method has at present only been used once on the living subject, and that a dog. It was entirely successful, and when the animal was killed on the fifteenth day, the union was absolutely water-tight, and there was no material contraction. The following **advantages** are claimed by Dr. Rogers for this method: (1) It can be done with the aid of the instruments in a pocket-case, ordinary round sewing needles being used (although curved intestinal needles are to be preferred), and with very little assistance, and is therefore likely to be of especial service in military surgery or in country or foreign practice. Yet (2) it can be completed in about half an hour, or only a little longer than the time required with the aid of such special appliances as plates, buttons, and bobbins. (3) The junction is a double sero-fibrous one, and hence, as Mr. Greig Smith believes (*loc. infra cit.*), will combine the maximum of rapidity and firmness. (4) The mesenteric junction can be made very firm by the apposition of the muscular coat of one end to the peritonæum of the other, and subsequent covering up of this suture by the reflected peritonæum.

MODIFICATIONS OF CIRCULAR ENTERORRAPHY. AIDS TO ITS PERFORMANCE, OR MEANS OF REPLACING IT.

Owing to the objections which some have raised against circular enterorrhaphy, other methods have been invented. I propose only to describe those which have stood the test of successful trials in the human subject, as well as giving good results in animals.

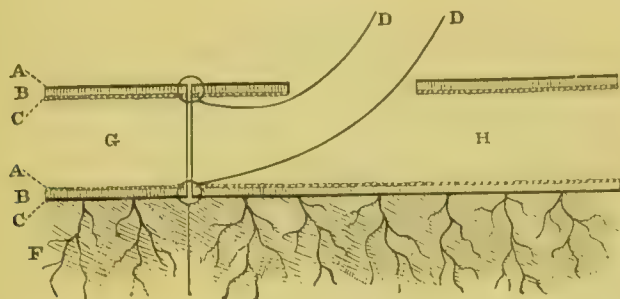
Method of Maunsell.†—This modification of circular

* This method has not yet been used on the living human subject. In his departure from the usual rule of uniting the serous coat to serous, Dr. Rogers has followed Mr. Greig Smith (*Brit. Med. Journ.*, 1895, vol. i. p. 1).

† H. Widenham Maunsell, late Lecturer on Surgery, Otago University (*Amer. Journ. Med. Sci.*, March 1892). The inventor used his method first as long ago as 1886, after resection of the small intestine "for cancer" in a child aged six. The child sank on the sixth day; at the autopsy the segment of the intestine showed no evidence of leakage. Dr. Wiggins, *New York Med. Journ.*, Dec. 1, 1894, and in his pamphlet, for which I am indebted to him, relates a successful case in which he resected six inches of ileum for contusion and perforation, uniting them by this method. The patient was well ten months later. Dr. Wiggins mentions a case of Dr. Harley's, *New York Med. Journ.*, vol. lvi. pp. 302 and 464, in which

enterorrhaphy is based on the fact that, when Nature performs enterorrhaphy successfully, she does so by the process of invagination, adhesive inflammation, and sloughing. The two ends of the bowel* are brought together by two temporary sutures passed through

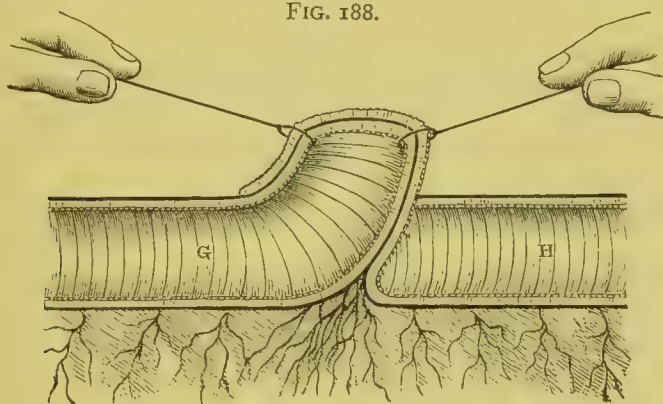
FIG. 187.



This and the next three figures show Maunsell's modification of circular enterorrhaphy. A B C. Peritonæal, muscular, and mucous coats. F. Mesentery. D D. Temporary sutures by which the lower is invaginated into the upper end. They are seen to emerge through a slit in the latter. (From Walsham's *Surgery*; copied from Maunsell, *loc. supra cit.*)

all the coats of the intestine (D, D, Fig. 187), one being placed at the mesenteric junction and the other exactly opposite. These sutures secure the peritonæal covering of the intestine, and serve,

FIG. 188.



G. The interior of the lower segment which is invaginated into and through the opening in the upper segment H.†

later, to effect invagination. A slit about $1\frac{1}{2}$ inch long having been made in the long axis of the free border of the proximal part of the intestine, about an inch from the divided end of the gut, the long sutures are passed up through the lumen of the bowel and

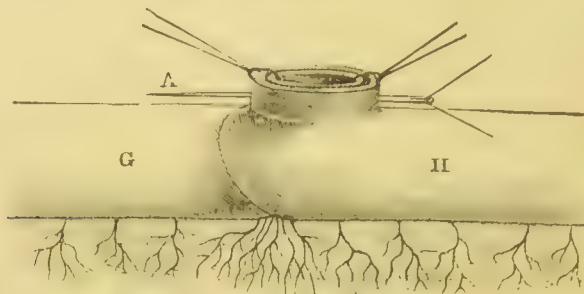
this method was also successfully employed for the resection of a double intussusception and carcinoma.

* The preliminary steps as to clamps, &c., would be the same as those given at p. 858.

† Mr. Stanley Boyd in his case made the incision in the distal end, and invaginated, with a little difficulty, the upper larger into the lower small end.

out of the slit; when pulled upon, the smaller or distal end of the bowel will be invaginated into the larger and drawn out of the opening in this (Fig. 188). From this figure, which shows the

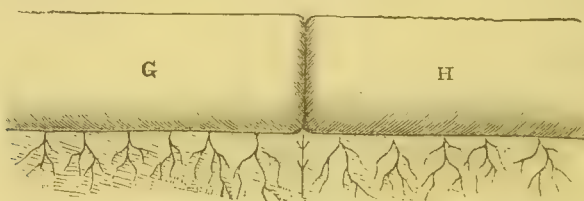
FIG. 189.



A. The needle introducing two sutures by a single transit. G and H as before.

relative position of the layers invaginated, it will be seen that the peritonæal surfaces are in accurate apposition all round. While an assistant holds the ends of the temporary sutures up and apart, the surgeon passes a long, fine, straight needle, carrying stout horsehair, or very fine silkworm gut, through both sides of the bowel, taking a good grip (a quarter of an inch) of all the coats (Fig. 189).

FIG. 190.



This shows the line of junction, the peritonæum well turned in, and the sutures and knots nearly all inside the gut. One or two sutures are seen in the mesentery. G and H as before. Above H would be the longitudinal slit sewn up by a continuous suture.

The suture is then hooked up from the centre of the invaginated gut, divided, and tied on both sides. *In this way, twenty sutures can be rapidly placed in position with ten passages of the needle.**

* Mr. Stanley Boyd introduced here two or three modifications of this important stage, which may be useful. Finding that time was lost in drawing up the loops from the lumen of the bowel, and in selecting corresponding ends, he passed many of these sutures not across the lumen of the bowel but through only two walls, and tied the sutures as they were inserted. He found that great care was needed to ensure that the cut edges of the peritonæal coats were equally drawn up, and that each stitch passed a good quarter of an inch below them, for the mucous membrane tends to prolapse and to conceal the peritonæal edges which are of chief importance. Finally, finding the ends of the wet silk difficult to push up and disentangle, he used horsehair. This if sterilised, and not brittle, is, as Mr. Boyd says, a safer material for a penetrating stitch. The late Dr. Maunsell strongly recommended it as superior to silk. The longest and strongest hairs, without a flaw, must be selected. Those from the mares' tails are unreliable,

The temporary sutures are now cut off short, the sutured ends of the bowel painted with Woelfer's mixture of alcohol, glycerine, and colophonium, and dusted with iodoform. The invaginated gut is then pulled back.* Finally, the longitudinal slit in the gut is well turned in, and closed by a Lambert's continuous suture, and painted and dusted as above. The appearance of the gut is now as in Fig. 190; the serous surfaces should be in accurate apposition, and all the knots inside the bowel. Dr. F. H. Wiggin (*loc. supra cit.*), comparing this method and Murphy's button, pointed out the following as requiring careful attention when this method is employed: 1. The mesenteric border must be carefully approximated. 2. The sutures must be interrupted, and not placed too near the edge of the intestine; they should be placed a quarter of an inch from it at least. 3. They must not be tied too tightly. 4. Too much force must not be used in reducing the invagination, or the sutures may cut out. 5. In closing the longitudinal incision, too much of the edges must not be turned in, or a contraction may result.

While this method is less alluring than Murphy's button, and cannot be used so rapidly, it has certain **advantages** over it which it shares with circular enterorrhaphy, and certain peculiar to itself. Thus, it needs no mechanical device, which may not be at hand just when wanted. It requires only a few needles, silk or horsehair. Thus, in Dr. Wiggins's account of his own case, in which he resected six inches of the ileum for contusion and perforation, uniting the ends by Maunsell's method, he writes (*loc. supra cit.*): "The urgency of this case was great. The patient was in a country farmhouse. The operation could not have been safely delayed one hour longer than it was: consequently, there was no time to procure mechanical devices from the city. A few instruments, a paper of ordinary sewing needles—milliners' No. 6—and some iron-dyed silk were easily procured, and the operation was promptly performed, and the patient's life saved."

The advantages which are claimed over circular enterorrhaphy are that this modification is speedier of execution, and that it gives easier command over the hæmorrhage. A third is that, when the ends are of unequal size, they can be more readily dealt with by the invagination of this method than by circular enterorrhaphy. The chief objection to be brought against it is the additional wound through which the temporary invagination has to be made. Having compared this method with Murphy's button (p. 840), it

being often rotten with urine. When selected they should be well brushed in soap and water. They are then next placed to soak in a mercury bichloride solution for two or three hours, then shaken out and placed in a large glass-stoppered bottle. Before being used, the hair should be soaked for three hours in a similar solution to make it pliable (*loc. supra cit.*).

* If, now, there is any doubt about the line of suturing, a few Lambert's sutures should be added externally, especially about the mesenteric junction; or an omental graft (p. 867) may be added (Stanley Boyd, *Med. Chir. Soc. Trans.*, vol. xxvi. p. 345).

is right that I should add that Dr. Ricketts, of Cincinnati (*Ann. of Surg.*, vol. i. 1894, p. 473), after resecting four inches of the ileum for carcinoma, on attempting "to make a Maunsell operation," found that the distal end of the gut was so fixed, it being only five inches from the ileo-cæcal valve, that more time would be consumed than was for the good of the patient. He accordingly used the Murphy's button, which took only eight or ten minutes. The patient, who had persistently refused operation, sank ten hours later. Dr. Ricketts, while "satisfied that the button was the most appropriate in this case," is "thoroughly convinced that the Maunsell operation is the one to be used in the majority of cases."

Mayo Robson's Bobbin (Figs. 191, 192, 309).—This method appears to me likely, for the present at all events, to replace all the other special apparatus which have been invented to aid in the resection or anastomosis of the stomach and intestines.

Mr. Robson (*Brit. Med. Journ.*, vol. ii. 1895, p. 963) states that after using or seeing used all the other usual contrivances, *e.g.*, Senn's plates, Murphy's button, and Paul's tubes, he has returned in enterectomy to the use of the bobbin, which "I infinitely prefer, not only on account of its simplicity and safety, but because it can be employed quickly, secures an immediately patent channel, leaves no foreign body permanently in the passage, avoids stricture by securing continuity of mucous surface, and can be adapted to any of the operations on the intestinal canal."* Another advantage which may be safely claimed is that these bobbins are much more easily introduced when one segment of intestine, *e.g.*, the lower usually, is much narrower than the upper. Again, from their shape, they obviously will exert much less tension upon the intestinal wall and the sutures which hold them together, than the plates of Prof. Senn.

The decalcified bone bobbins were in their first issue like a cotton reel, the rims at the ends being (Fig. 191) made larger than its centre in order to prevent the body shifting from its place until its pressure is not needed. These rims being found too prominent the bobbin was modified as shown in Fig. 309. The following account is taken from *La Sém. Méd.*, *loc. infra cit.* (Figs. 191, 192): "It seemed that if one could secure continuity of the mucous coat across the new aperture by means of a continuous suture (Fig. 191) sewn around a tube without the risk of narrowing the size of the orifice, one would be able to avoid consecutive cicatricial narrowing. The union of the serous surfaces could be assured by means of a sero-serous suture made in the same way as the mucous. 1 ctm. or $1\frac{1}{2}$ ctm. from the edges of the incision, so removing all risk of extravasation (Fig. 192). The operation is facilitated by beginning with the sero-serous suture for the posterior half of the

* It will be a very great gain if surgeons find, as claimed by Mr. M. Robson (*La Semaine Médicale*, 1892, p. 485), that there is one contrivance ready to their hands, calling for much the same technique in all such varied operations as enterectomy, intestinal anastomosis, ileo-colostomy, pylorotomy, pyloroplasty, cholecystenterostomy.

For "Fig. 309," on pages 836, 837, 838, read "Fig. 299."

[To face p. 836.]

incision, then putting in the muco-mucous for the same extent. The tube is then put in place, the muco-mucous suture next completed, and finally the anterior half of the sero-serous. As seen in Figs. 191, 309, the bobbins are made in different sizes.

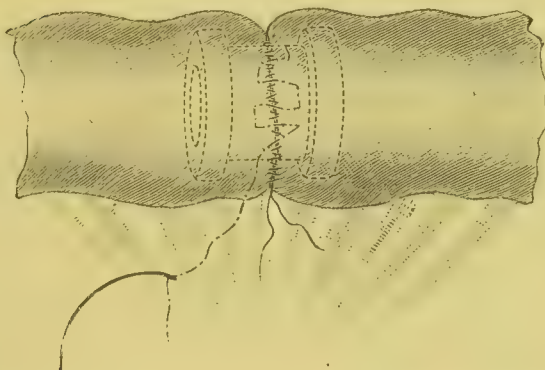
Mr. Mayo Robson (*Brit. Med. Journ.*, vol. ii. 1895, p. 965) stated that while usually employing two sutures, the mucous and serous, with his bobbin, he has not hesitated to use only one continuous

FIG. 191.



The continuous muco-mucous suture. (Mayo Robson.)

FIG. 192.



The continuous sero-serous suture. Below is seen the knotted end of the muco-mucous stitch which will shortly be shut in. (Mayo Robson.)

stitch to unite the whole thickness of the gut where time was an object in the case. In this case he claims that the bobbin-operation can be done more quickly than that with the button and at the same time he believes that it will give greater security against leakage and a much firmer bond of union. When the double suture is used Murphy's button will, Mr. Robson thinks, only save three or four minutes, and he points out that his five cases of colectomy are living examples of the contrast of the after-progress of the two methods. Thus in cases i. ii. and v., where the bobbin was used, an uninterrupted recovery followed, in case iii. Murphy's button took forty-four days to pass and caused partial obstruction on several occasions. In a list of cases which Mr. Robson prepared in order to illustrate a paper read before the Clinical Society (*Brit. Med. Journ.*, vol. i. 1896, p. 451), the bobbin was used in seven cases of enterectomy, and out of these six have recovered.

The following **advantages** of this method have, it seems to me been fairly established. (1) It facilitates and simplifies circular enterorrhaphy. (2) The foreign body on which it depends is safely dissolved, instead of being left behind to come away, thus often giving rise to anxiety. (3) There is no sloughing connected with its *modus operandi*; it prevents subsequent stricture by establishing a continuous mucous canal, without the stage of healing by granulation. (4) Owing to the size of the bobbin, and there being no sloughing connected with it, the opening provided is sufficient and permanent. (5) Though at present it has not been very largely used, the percentage of successes is very high. In his paper read before the Clinical Society, Mr. Robson showed that the use of the bobbin had been attended by a mortality as low as 8 per cent. (6) Last, but by no means least in importance, is the fact that the button is adaptable to a very wide range of operations. The only **objection** to it is one common to all mechanical devices—*i.e.*, that it is not always to hand. In, however, its cheapness, its great variety of sizes (Figs. 191 and 309), the readiness with which it can be prepared, it contrasts very favourably with Murphy's button while from its greater facility of introduction, absence of somewhat perplexing threads, and the safer tension it exerts upon opposed or approximated segments, it seems to me to be a distinct advance upon the bone-plates of Prof. Senn, making all due allowance for the excellence of the work which these earlier devices of a very brilliant pioneer in abdominal surgery have done.

For the above reason it seems to me probable that, as I have said before, Mr. Mayo Robson's bobbin, or some other bobbins, will be, for some time to come, the mechanical device most largely resorted to.

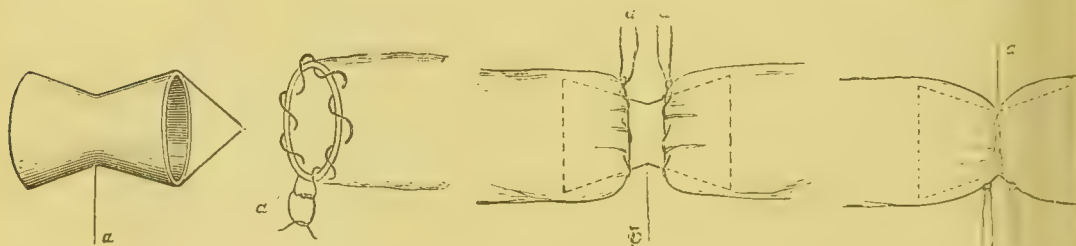
Allingham's Bobbin (Figs. 193 to 196).—Mr. H. Allingham has introduced a bone bobbin which differs from Mr. Robson's in

FIG. 193.

FIG. 194.

FIG. 195.

FIG. 196.



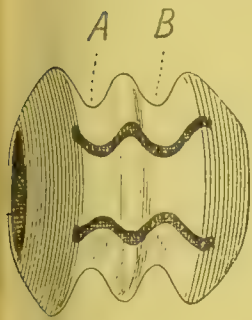
shape and structure. It consists of two cones with the apices united in the centre (Fig. 193). They are decalcified to within about $\frac{1}{16}$ th of their centre. The junction of the two cones is hard and unyielding to meet any pressure from the sutures when tightened. Besides the advantages of other bobbins it is

* Mr. Bowlby, in the discussion which followed Mr. M. Robson's paper, emphasised the advantage of the bobbin in securing the immediate passage of flatus and faeces.

claimed that this one cannot slip away, and that when the sutures are tied the parts resected are brought together without excessive pressure on the edges of the bobbin. A purse-string stitch (Fig. 194), is run round each end of the gut: then one end of the bobbin is inserted into one segment of the intestine and the suture is pulled tight by a knot twice threaded (Fig. 195), which will not slip, but the final tie is not made until the other end of the bobbin has been inserted into the other segment of intestine. After this each suture is tightened to its utmost, the ends of the intestine being thus drawn down to the centre of the bobbin (Fig. 196), which from its shape ensures that the tighter the sutures are drawn, the more securely must the intestine ends be drawn to meet in the centre of the bobbin. A few Lembert's sutures or a continuous Lembert's suture may be used if thought desirable. It is well to lightly scarify the serous coat for $\frac{1}{2}$ inch around the union to promote exudation of lymph. This button has been successfully used once on the human subject by Mr. Allingham.

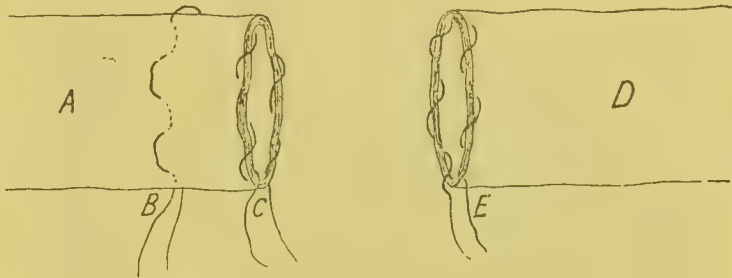
Hayes' Bobbin (Figs. 197 to 199).—Mr. Hayes has devised

FIG. 197.



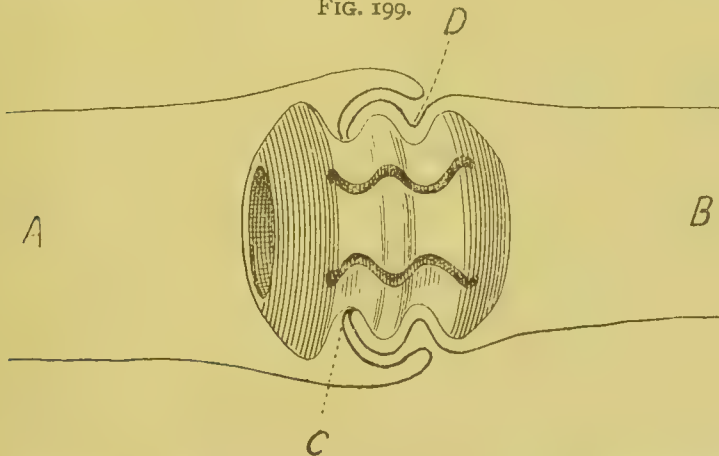
A B. Central part not decalcified, partly segmented by saw-cut. C. Lumen in decalcified end.

FIG. 198.



A D. Proximal and distal intestine. C E. Purse-string sutures. B. Sub-serous purse-string suture, by which, after union of the intestine, one part is invaginated over the other.

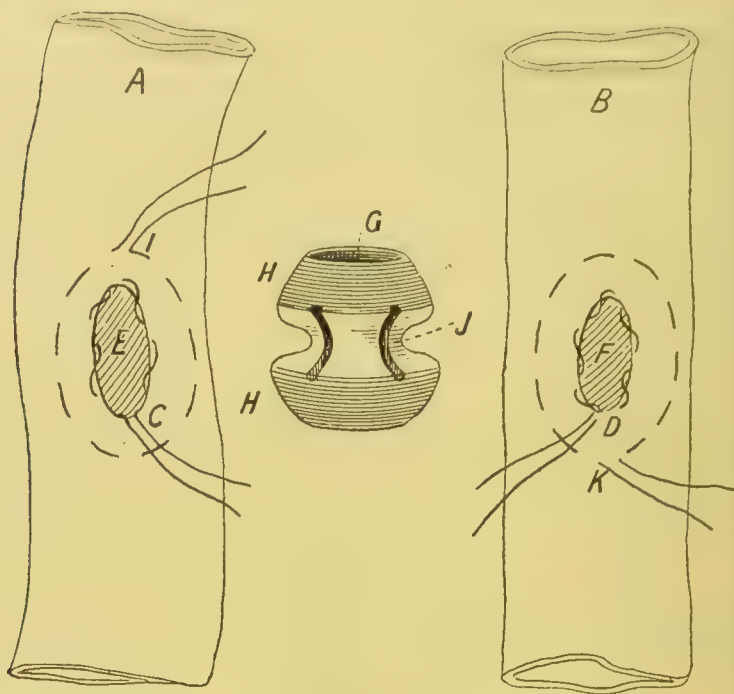
FIG. 199.



C. Proximal groove in which the two marginal sutures secure the orifices of the two parts of the intestine, A and B. D. Distal groove where sub-serous purse-string presses the proximal intestine over the invaginated distal part.

(*Lancet*, vol. i. 1895, p. 1619) another ingenious button, partially decalcified, by which he obtains additional security by easily ingenerating one piece of resected intestine within the other. It is

FIG. 200.



Lateral anastomosis by Hayes' bobbin. E and F. Apertures to receive the bobbin. D and C. Marginal sutures. K and I. Sub-serous purse-string sutures.

stated whether the bobbin has been successfully used on the living subject. The drawings are so clear that they explain this method of themselves.

Murphy's Button (Figs. 202 to 205 and 227).—This, one of the most ingenious inventions of the century, we owe to Dr. J. B. Murphy of Chicago (*New York Med. Record*, Dec. 10, 1892). Its great advantage is the facility and rapidity with which end-to-end approximation can be effected without any sutures. The button consists of two halves. The male half has a spring flange for keeping up pressure on the intestine ends. Two springs (s, s), projecting through openings in the hollow stem, act as a male thread of a screw, when the male half is telescoped within the female half of the button. When the button is used to unite resected ends of bowel* a puckering or running thread is passed round each side to and from the attachment of the mesentery, and especial care is taken to close the triangular interval which exists here (Figs. 186, 202, 216, 217) by means of the return stitch. One half of the button held as in Fig. 203 is then inserted in the intestine and the running thread so

* Its use in effecting lateral anastomosis is given at p. 873.

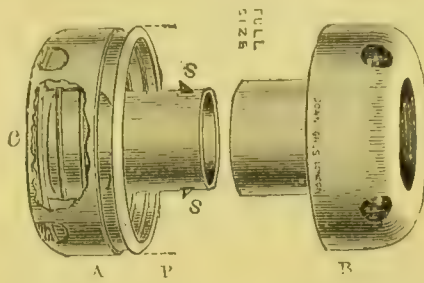
lightened as to pucker the cut end of the intestine with sufficient closeness and tightness around the shaft of the button. The ends of the thread are then tied and cut short. The other half of the button having been secured in the opposite end of the intestine (Fig. 205) the two halves are gently* pressed together, the surgeon having first made

FIG. 202.



b. Puckering thread. a shows the return-stitch by which the interval between the two layers of the mesentery is closed, a very important detail. (Down's Pamphlet.)

FIG. 201.



Murphy's button. A. Male half. B. Female half. P. Spring-flange. SS. Springs projecting through openings in hollow stem. At C part of the cap of the small half has been cut away to show the circular spring which keeps up the pressure as the button does its work. The round holes in the caps are for drainage. (This and the next four figures are borrowed from Down's Pamphlet, 1894.)

sure that both cut ends are, all along their edges, within the grasp of the button. The two halves are pressed together until it is seen that the peritonæal surfaces are held in sufficiently close and accurate contact. Dr. Murphy holds that it is needless to apply Lembert's sutures with the button between the serous surfaces, and that scarification of these is also unnecessary.†

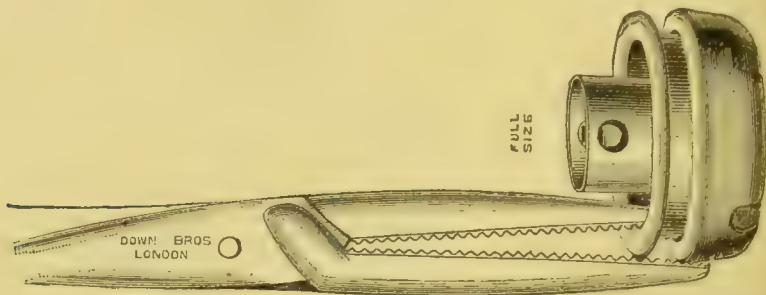
Dr. Murphy (*Lancet*, vol. i. 1895, p. 1040) claims for his button that in resection of intestine for gangrenous hernia, it has been used twelve times, with two deaths. In resection for malignant disease there have been thirty operations with seven deaths, these thirty including eight cases

* Chicago, *Chic. Rev.*, June 1894.

† The following precautions are given as to the button and its use. The edge of the cup should never be sharp, but possess a line of surface. The spring must not be too stiff, or it might produce too rapid sloughing. The locking should be easy. Unnecessary handling of the buttons should be avoided. They should be left partially unscrewed, until wanted for use.

of resection of the cæcum with but one death. With regard to two of the cases of fatal peritonitis, Dr. Murphy points out that in one the button was too large and fitted too tightly. To prevent this the button should fit easily. In another case both ends of the intestine were found to be gangrenous at the autopsy. This is stated to have been due not to the button, but to the length of time during which the intestine was clamped during the operation.

FIG. 203.

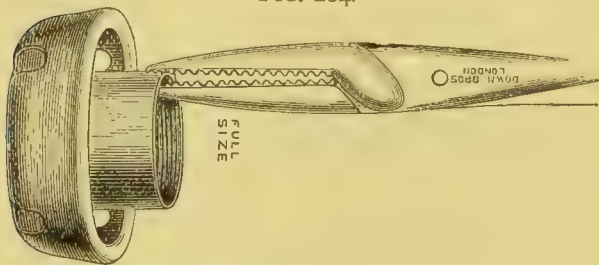


Showing method of holding male half of Button for insertion.
(Down's Pamphlet.)

The *modus operandi* of the button is based upon the following principles: (1) It retains apposition automatically—that is, without suture. Thus the danger of shock, the length of the manipulation and exposure of the intestine, the risk of infection, post-operative paralysis and adhesions, are very greatly lessened, and an immense saving of time secured.

(2) The pressure-atrophy is produced by elastic pressure; this being uniform and continuous, the assurance of adhesions is greater and the risk of infiltration less. It produces juxtaposition of the edges of the same coats, thus minimising the interposition of

FIG. 204.

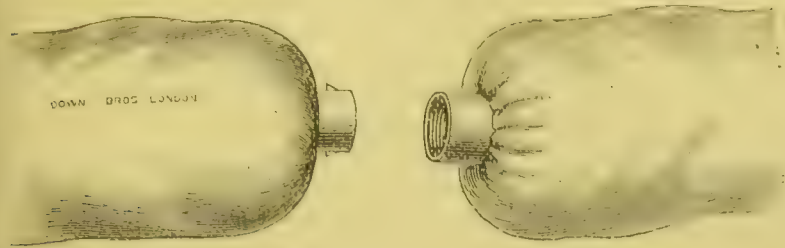


Showing method of holding female half of Button
for insertion. (Down's Pamphlet.)

fibrous tissue, and perfecting the regeneration along the line of union. As a result, the union is accomplished by the smallest possible cicatrix, and therefore must yield the least contraction of any operation. Believing that he had absolutely established the above, Dr. Murphy claimed that his button attained the best results in intestinal approximation, because it best attained the following ends: (a) Accurate contact of surface. (β) Speedy and permanent adhesion of the approximated surfaces. (γ) An opening sufficiently large for immediate purposes. (δ) A cicatrix that will not contract harmfully. (ε) The accomplishment of all these in the most *simple* and *rapid* manner. **Objections.** Dr. Murphy's method is so alluring in its ingenuity, the simplicity

and readiness with which it can be applied are so evident that there is some danger of its disadvantages* being lost sight of.

FIG. 205.



Murphy's method of end to end approximation of divided intestine. The two halves of the button, each secured by a puckering thread, are ready to be pushed home. (Down's Pamphlet.)

The following appear to me to be established:

(1) Contraction of the orifice.† When the *modus operandi* of the button is considered this risk must always be remembered. In the words of an American surgeon who has taken much practical interest in Intestinal Surgery, Dr. McGraw of Detroit: In the operation by Murphy's button, the button becomes detached by crushing the rim of tissue around the opening of communication until it sloughs and gives way, leaving behind a granulating wound, disposed to close after the nature of such wounds" (*Ann. of Surg.*, vol. ii. 1893, p. 315). A case of Prof. Keen's of ileo-colostomy for carcinoma of the colon, by means of the button, is an instance of the truth of the above.

The button had been passed on the twelfth day, "together with a slough consisting of the rings of tissues between the two halves of the button. The patient died very suddenly of a perforating ulcer of the colon forty-seven days after the operation, and the autopsy showed that the opening had already contracted to one half of its original diameter.

Prof. Keen considers the possible contraction of the anastomotic opening, "the pivotal point upon which rests the utility of the button."

Dr. Dawbarn of New York, a strong advocate of vegetable plates in intestinal surgery, had earlier (*Ann. of Surg.*, vol. i. 1893, p. 155) expressed a fear which this case of Prof. Keen's proves to have been well grounded. "In performing cholecystenterostomy (the button) really seems an ideal plan; but upon stomach and in uniting bowel to bowel, because of the primary small calibre of the new opening (still further to be reduced with time), I venture

* Dr. Murphy in a very interesting paper on "Operations with the Murphy button," (*Lancet*, vol. i. 1895, p. 1040), makes, I think, too light of these. Several of his conclusions as to contraction of the scar left by the button, fecal impaction, and sloughing, are, it seems to me, not justified by the published cases *vide infra*).

† Dr. Murphy (*loc. supra cit.*) states first amongst the conclusions at which he has arrived—"The cicatrix produced with the button does not contract." No mention is made of Prof. Keen's case given below.

to predict a justified lack of acceptance by the profession." The following case of Dr. R. Abbe of New York (*Ann. of Surg.*, Apr 1895) shows that even after cholecystenterostomy such stenosis may follow as to prevent fluid contents such as bile passing.

About a year before Dr. R. Abbe had opened the gall-bladder, establishing fistula in a woman who had cancer involving the head of the pancreas, and first part of the common duct, causing obstruction and distension of the gall-bladder. The patient's condition having greatly improved in six weeks, Dr. Abbe established an anastomosis between the gall-bladder and duodenum with a Murphy button. This was passed on the twelfth day. The patient remained in excellent health for eight months, when symptoms of gallstone colic recurred making it probable that stenosis was taking place. The symptoms returned, and the patient died in the third attack with cholæmia and convulsions. The opening created between the gall-bladder and duodenum had become absolutely closed by cicatricial contraction ten months after its establishment. The malignant disease had not invaded the anastomosed parts.

(2) Sloughing at the line of junction, and extravasation of fæces. The following case of Dr. Abbe's (*Ann. of Surg.*) is a proof of the risk of the above.

The patient was admitted with obstruction due to carcinoma of the sigmoid. Owing to the distension and the condition of the patient a lateral anastomosis above and below the cancer was done with a button.* Six weeks later resection was undertaken, owing to the pain felt locally. The anastomosed gut was resected, and an end-to-end anastomosis made "by a large button which fitted rather snugly in the lower end." The cancer had by this date invaded the lumbar wall. A counter-opening was made behind, and the anterior one closed. On the fourth day fæces appeared at the lumbar wound. On the sixth day this was freely opened and the intestine found to be sloughing on either side of the button. On the seventh day the patient died exhausted.†

(3) Septic peritonitis due to sloughing of the intestine over the button. When we consider that in anastomosis of the intestine we can never keep the field of operation aseptic, and that whatever method we use, needles, sutures, plates, buttons, &c., may all be the means of increasing the risk of sepsis, no surprise will be felt when occasionally cases are published in which septic peritonitis has followed on the use of the button. Its *modus operandi* is by setting up a limited pressure-gangrene or sloughing. In many cases this process will be limited, but it is manifestly impossible to control or limit such a process, and occasionally fatal results will be met with from this cause.

Mr. Harrison Cripps (*loc. supra cit.*) mentioned a case in which a patient died in two or three days from acute septic peritonitis due to sloughing of the intestine over the upper half of the button.

* It is stated that the first button was never passed, but there is no information whether this was cleared up later, either at the time of the resection or at an autopsy.

† It is only fair to Dr. Murphy to point out that this was a very severe test for his method. The patient was "not in very good condition after the operation," and it is possible that the separation of adhesions and the extension of the growth had interfered with the blood supply of the intestine, though this is not stated. On the other hand, Dr. Abbe's well known skilfulness was in the favour of the method.

Prof. Senn speaks very strongly on this point (*Journ. Amer. Med. Assoc.*, vol. ii. 1893, p. 232): "It is impossible to effect an aseptic incision in the interior of the bowel; the dead tissue inhabited by pathogenic microbes always constitutes a source of danger. It is easy enough to produce gangrene, but we are powerless in limiting its extension in this locality. The limited area of living tissue brought in contact outside of the rings of the Murphy button will not always prove adequate in the protection of the peritoneal cavity against perforation and its immediate result—septic peritonitis. I have knowledge of a number of cases in which the parts approximated by the Murphy button were found completely separated at the post-mortem examination."

(4) Retention of the button, causing obstruction. I shall allude to a case under the heading of Gastro-jejunosomy (p. 932) where the button has not been passed but no harm has followed.*

The following show that the button may cause fatal obstruction.

Dr. R. Abbe (*Ann. of Surg.*), has related a case of resection of the caput coli and ascending colon for cancer in a patient aged forty-two. An end-to-end anastomosis was easily made with a medium-sized, easy-fitting, Murphy button. At the end of the second day there was abdominal pain, tympanites and vomiting. Strong desire to defæcate was futile, even with the aid of a high enema. Saline cathartics were useless.* On the third day after the operation the greatly distended ileum was sutured to the abdominal wall and opened. A large amount of fluid fæces escaped with great relief. The patient died on the sixth day. The autopsy showed no peritonitis, but an empty colon below the button, and a hard plug of fæces in the button, which caused complete obstruction.

Dr. Kammerer (*Ann. of Surg.*) has recorded a case in which the button caused trouble by not passing in the small intestine.

The case was one of fæcal fistula, resulting from a gangrenous hernia. Anastomosis had been made by a Murphy's button. Thirteen weeks later the button had not been passed, but could easily be reached from the fæcal fistula which still persisted. Dr. Kammerer enlarged the fistula, and after much trouble succeeded in extracting the button. The patient did well for six days, when she developed symptoms of subacute peritonitis and died. The autopsy showed general peritonitis. The anastomosis had separated while the button was being removed, and the sharp edges of the incision into the bowel, showed that the adhesions, even after thirteen weeks, must have been very slight. Dr. Kammerer did not believe that the peritonitis was due to a separation at this point, but any other explanation for it was not apparent.

Mr. Harrison Cripps (*Brit. Med. Journ.*, vol. ii. 1895, p. 965), mentioned in the

* Mr. Clutton (*Brit. Med. Journ.*, 1896, vol. i. p. 845), during a discussion at the Clinical Society on Enterectomy, said that while his experience with the button had been very good, the trouble was that it did not pass. A patient of his had been operated on Nov. 1895; the button was still, March 1896, in her intestine.

† This is important, as it has been advised by Dr. W. Meyer and Dr. Murphy to resort to saline aperients early to prevent obstruction. Thus Dr. Murphy himself (*Lancet*, vol. i. 1895, p. 1047) states that fæcal impaction "can be easily avoided by a mild cathartic immediately after operation."

discussion on Colectomy, a case in which the patient died on the eighth day from perforative peritonitis caused by the button having become impacted six inches below the point of anastomosis, and having ulcerated through.

(5) Kinking and strangulation from the weight of the button. This is rare, but a case of Dr. Abbe's is related of this kind (*Annals of Surg.*).

Five inches of small intestine had been resected for gangrene in a hernia. The two ends having been joined by Murphy's method, the loop containing the button was replaced, and Bassini's operation performed. Before the wound was entirely closed, Dr. Abbe looked in and noticed that the upper end of the gut was still distended. This was due to the button kinking the gut as it lay in the iliac fossa. The loop was accordingly pushed towards the middle of the abdomen, in the belief that it would settle and rest easily among the other coils. Symptoms of strangulation recurred, and 48 hours after the first operation Dr. Abbe reopened the abdomen and found the kink persisting, the bowel having gravitated to the lowest point in the pelvis. The patient only survived the operation a short time. It seemed that the weight of the button had given rise to the acute obstruction by sharply bending the gut. Probably this was aided by the paralysed condition of the bowel so common in these cases.

(6) Mr. Mayo Robson, in his recent speech at the Clinical Society, pointed out that if any error was made in applying the button, it might be impossible to unfasten it for readjustment. He stated that under such circumstances an operator in order to set the button free, had found it necessary to excise afresh the portion grasped by the button.

(7) Another objection of a very different kind may be just alluded to, and that is, its expense, and the difficulty of always having the right size at hand. This in no way detracts from the ingeniousness of the button, nor do I bring it forward as a serious objection. It is right, however, that it should be mentioned when this mode of intestinal junction or anastomosis is fairly weighed with enterorrhaphy, Robson's bobbin, &c.; this last is, of course, required in several sizes, but being far less expensive will be more readily near at hand in sufficient variety.

I am well aware that these cases given above are but few when compared with the large number of brilliant successes which Dr. Murphy's button has attained. It is right, however, that they should be published, as there is strong reason to believe that the button has been used on many occasions unsuccessfully, these cases never being published. Again, it is noteworthy that the failures which have been published have occurred in the hands of most skilful surgeons. I fear that the extreme ingenuity of the button, the facility with which it can be used, may tempt men far less competent to perform operations for which they are unfitted, with results that will not be made public. König (*Centr. f. Chir.*, No. 4, 1895), I find, has expressed the same view. Thus "the use of Murphy's button may extend the practice of resection, and so enable inexperienced surgeons to perform these operations, but this, from the patient's point of view, is rather a disadvantage than a sign of advance."

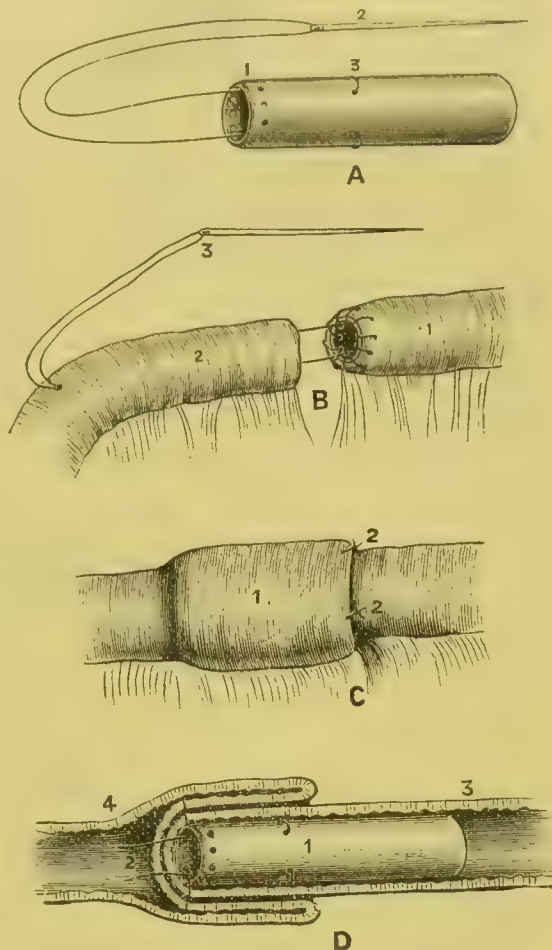
Paul's Method (*Liverpool Med. Chir. Journ.*, July 1892). Figs. 206 to 209). Here end-to-end union of divided intestine is brought about by invagination aided by a bone-tube. The method is as follows:—

First, the operator is prepared with a decalcified bone-tube, like that shown in the diagram A, to which is attached a needle and a strong silk thread, called the traction-thread. The tube is required chiefly to enable the operator to produce an invagination of the bowel which will cover the line of union; but it is also useful for keeping open the channel of the intestine, and as a splint to keep the parts quiet during the early stages of repair.

The piece of bowel having been excised, the tube is sewn into the upper end: with a continuous suture of chromic gut or silk passing through the holes in the tube and taking up the serous and muscular coats of the bowel, the traction-thread is then passed through the wall of the lower segment about three inches down, as in figure B. Next, the two cut ends of bowel are quickly attached to each other with a continuous silk suture. An assistant now draws firmly on the traction-thread, whilst the operator produces a short invagination which is retained in position by three or four Lembert sutures (Fig. 206, 2, 2, 2.) Finally, the traction-thread is drawn tight and cut off short, its ends dropping into the bowel.

It is claimed for this operation that—(1) the closure is absolutely secure so long as the bone-tube remains intact, or until sloughing

FIG. 206.



A. The decalcified bone-tube. 1. The lower or distal end perforated for sewing to the bowel. 2. The traction-thread armed with long sewing needle. 3. Its attachment to the tube.

B. A further stage in the operation. 1. The proximal end of the bowel with the tube sewn in. 2. The distal end not yet sewn to the proximal but (3) the traction-thread has been passed.

C. The operation completed. 1. The sheath or intussusciens of the invagination. 2. The Lembert sutures for retaining the parts in position.

D. The parts, shown in section. 1. The tube *in situ*. 2. The traction thread cut short. 3. The proximal end of bowel entering the intussusception. 4. The distal end supplying the returning and ensheathing layers. (Paul.)

has had time to occur; (2) a free passage is at once established (3) the opening does not subsequently diminish or contract. The

FIG. 207.



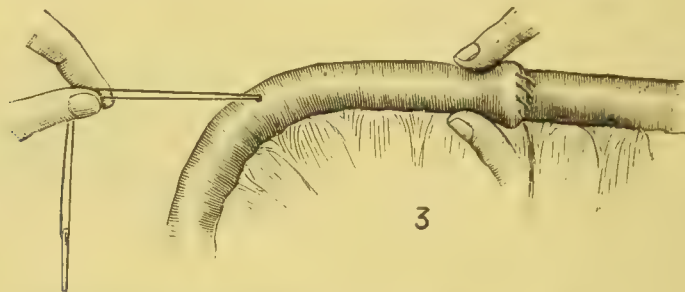
1. Showing the cut mesentery improperly allowed to gape. 2. The mesentery drawn together; but the diagram wrongly indicates a stitch passing through the bowel *without* piercing the mesentery. (Paul.)

bone-tube is gradually disintegrated and will, probably, not be seen again.

When invaginating, an error must be guarded against. The invagination is most easily produced by allowing it to commence about half an inch or so below the tube (Fig. 209). This means that the cut will be barely covered by it, whilst the lumen of the bowel will be con-

siderably blocked, and the operation consequently most imperfectly performed. It must be made to commence *immediately* below the tube by drawing the very first part of the lower segment upward

FIG. 208.



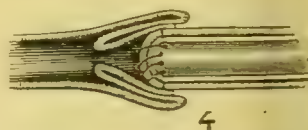
Producing the invagination *immediately* below the cut. (Paul.)

with the tips of the fingers (Fig. 208), and care must be exercised to observe that the mesenteric side of the bowel is as thoroughly covered by the invagination as the other side.

Mr. Paul has made use of this method with brilliant success in two cases of resection of gangrenous small intestine in femoral hernia (*loc. supra cit.*; *Clin. Soc. Trans.*, 1892; *Brit. Med. Journ.*, vol. i. 1894, p. 235). Mr. Horrocks of Bradford has also used this method most successfully in a case of resection of intestine for sarcoma. About 39 inches were removed, but the exact position is not given. It is noteworthy that as in this case and Mr. Paul's second one, owing to the dilated condition of the upper part of the intestine, it would have been difficult to invaginate the upper into the lower bowel, the lower was invaginated into the upper without ill-result.

Mr. Paul would only recommend his method for the small intestine, as most parts of the large are too fixed to admit of sufficiently free manipulation of the bowel.

FIG. 209.



The invagination carelessly produced. The lumen of the bowel is partly closed, and the line of suture barely covered. (Paul.)

Absorbable Plates.—The following substances have been used: (1) **Decalcified Bone**, by Prof. Senn; these are well known, and have been largely used. The mode of employing them is given in detail below, pp. 869, 872; (2) and (3), **Turnip and Potato**. These vegetable plates have been largely experimented upon in America and by a few Continental surgeons—Von Baračz, Heigl, and Butz—Dr. Dawbarn, of New York, seeming to have been the first to show experimentally that these vegetable plates could be used successfully. (*Ann. of Surg.*, vol. i. 1893, and Magill, *loc. infra cit.*). A little later, but independently, Von Baračz, of Lemberg (*Centr. f. Chir.*, 1892, p. 575, and *Arch. f. Klin. Chir.*, Bd. xlv. S. 513–591), published a series of experiments and some successful cases of gastro-enterostomy, in which plates of this material were made use of. We first have to consider the advantages and disadvantages common to all absorbable plates, and then to compare the plates of decalcified bone with those of raw vegetable.

When Prof. Senn, to whom modern surgery owes so much, introduced the principle (*Intestinal Surgery*, 1889), the following were the chief **advantages** claimed: (1) To save time; (2) to do away with the evils resulting from too many sutures; (3) to secure a larger surface of approximation of the serous surfaces; and (4) to give complete rest to the parts which it is intended to unite.*

On the other hand, the following **objections** have been brought against the decalcified bone plates: (1) That they are expensive, tedious to prepare, and, as many sizes are required for various different contingencies, they are not likely to be at hand in an emergency; † (2) that the opening left is too small; (3) that they require for their absorption and disappearance several days after they have ceased to be needed; (4) that it is difficult to adjust the plates with the right degree of pressure when they are approximated. If they are tied too tight they will cause pressure-sloughing of the serous surfaces; on the other hand, if the plates are not held and approximated firmly enough, they may slide upon each other, and thus cause obstruction of the opening; (5) it is not easy to return the bowel and bone-plates unless the opening into the abdomen is a free one. This has been found to be the case after making use of them for intestinal anastomosis for gangrenous hernia.

* A useful paper by Dr. W. S. Magill, of Chicago, on the results obtained by the use of absorbable plates, will be found in the *Annals of Surgery*, Sept. 1894. Tables are given, and the writer maintains that in 87 operations there were only 20 deaths, a mortality of about 23 per cent., and that of these 20 deaths only one was due to the plates.

† Some surgeons have found that the plates are not easily preserved. I hardly think this fair to Prof. Senn. I have found no difficulty, by following his directions. Mr. Lockwood thus states his experience in characteristically terse and vigorous language. "My own experience of bone-plates is as follows. Intending to try them upon a suitable occasion, a bottle-full was obtained from the instrument maker. These dried up and became hard and horny. Others were procured, but they disintegrated and formed a kind of mud at the bottom of the jar" (*Med. Chir. Trans.*, vol. lxxvii. p. 198).

Of **Vegetable Absorbable Plates** * I can say nothing at first hand, having never tested them nor seen them used. They are strongly recommended by some American and one or two Continental surgeons (p. 849), who claim that these plates have all the advantages of Senn's bone-plates, and others peculiar to themselves—viz.: (1) They are very cheap; (2) they are always at hand, being readily made out of materials—turnip or potato—which are easily obtained; (3) they quickly soften, and are absorbed when no longer needed; (4) they can be made with a large opening, viz., one, if desired, four inches long.

Comparison of Enterorrhaphy with the Chief Devices intended to Aid or Replace it.—Enterorrhaphy by circular suturing must be admitted to be the ideal operation from its simplicity, the entire absence of any especial apparatus, and the fact that no foreign body is left behind which may perhaps give trouble ere it come away. Those who condemn it as unsuccessful must remember (1) that it has been gradually and slowly perfected, being often laid aside for some new device and then resorted to again, and that it was very largely used in the earlier and darker days of intestinal surgery; (2) that when used by skilled hands it has proved most effective and reliable in the time of emergency.† When used by such hands—and it is one advantage of this method that it is easy for any operating surgeon to acquire skill in this method‡—care will be taken to fulfil the conditions necessary for successful enterorrhaphy, viz.: (a) sufficient inversion of the serous coats; (b) sufficient penetration of the coats without perforation of the lumen of the intestine; (c) careful adjustment of the junction of the intestine and the mesentery (Figs. 186, 216, 217), and (d) placing of the sutures in healthy tissues.§

It is right to state clearly here that many excellent judges, men well experienced in intestinal surgery, condemn circular enterorrhaphy. Thus Dr. A. B. Robinson (*Ann. of Surg.*, vol. i. 1891, p. 430), states that he found it, from experiments on dogs, very dangerous for the following reasons: (1) It paralyses the gut, and hence does not so readily relieve the fæcal obstruction which is the immediate object of surgical interference. To this it may be replied that, as shown at p. 855, the joining ends of intestine

* I have not mentioned catgut rings. They have been given up by the American surgeons who used them, having been found unreliable. After a very short time in the warmth and moisture of the intestinal contents they become quite limp and give no support.

† To mention a few cases only, I refer my reader to those of Mr. Lockwood and to Dr. McCosh's four successful cases of circular enterorrhaphy after resection of small intestine for gangrene. To such urgent emergencies, circular enterorrhaphy is especially suited if the surgeon has had sufficient practice to rely on himself.

‡ The only things needed are a packet of fine ordinary sewing needles, some silk, and different segments of intestine. These may be kept in dilute spirit.

§ The essentials of a good suture given at p. 826 should be referred to.

ected while obstruction is present should be deferred whenever possible, and when this is not possible, a rare contingency, the intestines should be thoroughly emptied before they are resected. This is not practicable union should be deferred and drainage continued by Paul's tubes, Fig. 181, &c. (2) A faecal fistula is apt to arise at the point of suture. (3) Gangrene or sloughing may arise from the pressure of numerous sutures. These are very serious criticisms. They must each be met by care in suturing, and attention to the junction of the intestine and the mesentery. (4) The lumen of the two ends may be unequal. When this difficulty is marked, circular enterorraphy must be abandoned for intestinal anastomosis. (5) Pathological changes due to obstruction of the bowel may offer impediments. The gut may be stretched so thin that a needle cannot be passed between the muscular and mucous layers without danger of penetrating the mucous layer and causing faecal fistula. I have pointed out elsewhere (p. 855), that resection of resected intestine is not to be attempted where obstruction, over-distension, &c., are present. Where the distension has been prolonged, as in malignant disease low down in the canal, circular enterorraphy is contra-indicated. This is not the case where the obstruction has been of shorter duration—*e.g.*, in gangrenous herniæ—as shown by the successful cases given at p. 861. (6) Circular stricture followed the experiments. Some of the sutures were so severe that both faeces and gas were actually obstructed. (7) The long time required for a circular enterorraphy militates against the chances of recovery. Of all surgery in the world, intestinal surgery should be rapid and skilful. Of the different methods Dr. Robinson recommends Lembert's sutures, using these continuous for two, three, or four stitches. This worked well and saved time, three to five interruptions of Lembert's sutures completing the circle round the gut. In this way a circular enterorraphy can be completed in less than half an hour. Dr. Robinson emphatically opposes a circular enterorraphy with a continuous Lembert's suture. "This was carefully tried, and the worst strictures of all resulted; not only that, but the thread gradually fell into the gut lumen, and its end dangled for days and even weeks there before it became entirely set free. This long thread will certainly be a dangerous source of infection, as infective fluids can go along it by mere capillary attraction, not to speak of the wider faecal fistula it may create." There is much weight in these last two criticisms. An increasing number of recent successful cases of circular enterorraphy, amongst these being one by Lockwood (p. 861), three by McCosh (p. 861), one by Fischhoff (p. 861), and many by Continental surgeons,* show that they are not unanswerable. As I have said elsewhere, skill can be obtained here by practice, and it is the above-mentioned most important saving of time which will be much facilitated by

* See the reference to Bier's cases (p. 829).

the use of Mayo Robson's bobbin, where a circular enterorrhaphy is being performed; especially if the patient's condition requires speedy completion of the operation, and the surgeon has not had much experience in enterorrhaphy. While these sheets are passing through the press, I have had the advantage of seeing a paper by Messrs. Ballance and Edmunds on Intestinal Surgery, with especial reference to the question of the best means of uniting resected intestine. I am very glad to have the privilege of quoting here on the technique of intestinal surgery the authoritative opinion of two workers who have proved themselves, in another part of the field of experimental surgery, most assiduous in research and withal cautious in drawing conclusions. The paper supplies a long-felt want in British Surgery. The following, very briefly put, are some of the conclusions to which the authors were led with regard to enterorrhaphy, and other methods of resecting intestine. With regard to end-to-end union the above-mentioned authors prefer simple suturing to the use of any form of supporting apparatus. They recommend either the Czerny-Lembert or Maunsell's method. Of five experiments on dogs performed by the former and two by the latter method, all did well. With regard to the Czerny-Lembert method, emphasis is laid on the care needed at the mesenteric junction and on the following facts. In the small intestine eversion of the mucous membrane takes place to such a marked degree that the insertion of the inner row of sutures only results in apposition of mucous membrane to mucous membrane. Thus the integrity of the junction depends solely on the Lembert's sutures. The result of the inversion produced by these is a ridge which remains at the line of junction, sometimes seriously contracting the lumen of the gut. This untoward result is especially likely to be brought about if the surgeon is uncertain about the efficiency of his row of Lembert's sutures, and is tempted to put in others, still further diminishing the lumen of the bowel. The above objection does not apply to Maunsell's method, which produces very perfect union, mucous coat being united to mucous, muscular to muscular, and serous to serous. After the Czerny-Lembert method a circular ridge or diaphragm is always to be found on laying open the intestine. This is not so after the Maunsell method: here it is quite difficult to recognise the line of circular junction, which point contrasts markedly with the ridge which is seen at the site of the longitudinal incision which had been closed by Lembert's sutures.

Of the different methods of producing lateral anastomosis Mr. Ballance and Mr. Edmunds consider Halstead's (Figs. 230 to 233) to be superior to all in which plates, bobbins, and other mechanical aids are used. The above-mentioned authorities emphasise one objection which applies to all of the above—viz., that the surgeon may very likely, in cases of emergency, not be provided with the size he requires. As to the claim that such devices shorten the time of operation, Messrs. Ballance and Edmunds reply: (1) That if.

as in Senn's method of anastomosis, sutures have to be placed around the plates (Fig. 224), the time taken is not much shortened. (2) Such a method as Halstead's lateral anastomosis does not take long if proper attention is paid to the following essentials: (a) A plentiful supply of round needles ready threaded with silk sufficiently thick not to cut the intestinal coats. (3) Using the needles as splints. Thus if, just as one thread is coming to an end the needle which carries it be left *in situ* transfixing the cut edges, this will keep the parts together and greatly facilitate the introduction of the next suture.

It is becoming increasingly clear, I think, that in the hands of an operating surgeon who has taken care to acquire skill by practice, the chief objections to Enterorrhaphy will be very greatly reduced—viz., the time taken, the number of sutures needed, the risk of perforating the lumen of the gut, of leakage at the junction of mesentery and intestine, and of stenosis from contraction of the cicatrix, especially if the inversion has been needlessly free. Where the surgeon from any want of faith in his skill, or from the condition of the patient requiring that the operation should be completed speedily, prefers to rely upon one of the devices intended to aid or to replace circular enterorrhaphy, he will be wisest in making use of Mayo Robson's bobbin. This, by giving support, facilitates the suturing at the time and supplies some of the conditions which are at the root of Senn's excellent principle—viz., the giving support to the ends of the intestine by a body which will be safely absorbed. From its shape, and its simplicity in its absence of threads, I consider this bobbin more easily inserted and used in effecting a direct junction of the ends than Prof. Senn's plates and lateral anastomosis, while its ready applicability to a very large range of different operations (p. 836), puts it, in my opinion, on an equal footing with Murphy's button, while the part which it is intended to play, and the material of which it is made, render it far safer than that most ingenious device, the objections to which have, I think, been somewhat unduly lost sight of owing to its ingenuity and the facility with which it can be employed.

The same absence of any threads to tie, and its wider applicability, make Mr. Robson's bobbin superior to Mr. Paul's decalcified bone tube, though, as I have stated at p. 848, several successful cases prove the efficiency of this device.

Next to simple enterorrhaphy, or enterorrhaphy aided by Mayo Robson's bobbin, given a case of junction of resected ends of intestine, I should put Senn's plates and lateral anastomosis (Fig. 225). This method, though less ideal, would be certainly superior where there was much difference in the calibre of the two ends of the intestine.

Where there is need for great speed, or where decalcified bone structures are not at hand, the surgeon will certainly be justified in resorting to Murphy's button, see p. 842, where its advantages

and disadvantages are, I hope, fairly put. While I will yield to none in my admiration of the ingenuity of this invention and the extreme facility with which it can be used, I do not consider the principles on which it is intended to act, or its *modus operandi* are as sound (p. 842) as those of the decalcified bone structure to which I have alluded. Furthermore, I am of opinion that while it has been very largely resorted to owing to the facility with which it can be used, successes have had somewhat undue weight attached to them. On the surface it would appear that there have, practically, been only successes. This is very far from the truth. In spite of the inventor's desire to publish a full list of cases, there are many unsuccessful ones which are never published (p. 844). Finally, it is at least remarkable that in America, to speak of the Murphy button in particular—where American inventions are particularly dear to the people—several leading surgeons have shown a distrust of this device; and to speak of such devices in general, it is at least noteworthy that in that land of very keen brains and very nimble fingers, there is an increasing tendency to revert from complicated inventions, however ingenious, to more simple methods of suture.

RESECTION OF INTESTINE. ENTERECTOMY. COLECTOMY.

Indications for Resection Operations.—The chief of these are (1) New growths. (2) Gangrene after strangulation in hernia or intestinal obstruction, (3) Injuries, gunshot or otherwise. (4) Some cases of irreducible intussusception. (5) Some cases of artificial anus where the canal of the intestine cannot be otherwise restored.

I propose to say a few words about the first two, the most frequent of the above indications.

The subject of Resection for Gunshot and other Injuries is fully dealt with in the next chapter.

(i) **Indications for Resection in New Growths.**—In deciding between resection and one of the forms of anastomosis without resection, or between resection and artificial anus, the surgeon should pay particular attention to the following points, both local and general. The more they are present, the more favourable is the case. Small size, definite outline, especially if the growth approaches the annular form, free mobility as pointing to absence of adhesions, entire absence of that tenderness which points to peritonitis or even to that breaking down and suppuration which may accompany new growths when they ulcerate and become septic, a situation in which the growth can be easily got at and isolated, *e.g.*, when it attacks a portion of intestine with a long mesentery, and not a fixed part such as the splenic or hepatic flexure.* These are the chief local points.

* In the tables of Weir (*New York Med. Journ.*, Feb. 13, 1886); Butlin (*Oper. Surg. of Malignant Dis.*, p. 231), of the 37 cases collected in which resection of

Amongst the general points that must weigh with the operator are the strength and nutrition of the patients, their fitness to bear a severe operation, and to supply the needful plastic repair.

Another point having a most important bearing upon the advisability of performing resection for malignant disease is whether this is complicated by obstruction, tympanites, &c. If there is one point which published (and still more the unpublished*) cases prove, it is that the occasion in which it is right to submit a patient the subject of intestinal obstruction to such a prolonged operation as resection and suture or anastomosis of the resected parts must be of the very rarest.† This is plain from the usual state of the patient in these cases, and the conditions within the abdomen with which the operator has to deal. Is a patient, usually past middle life, whose strength and powers have been sapped for days or weeks by the nausea, inability to take food, vomiting, distension, and of all the distress which forms part of a *miserere* of the later stages of chronic intestinal obstruction, in a fit state to go through a prolonged operation, and to supply after it the plastic repair which is needful for success? There can be but one answer here. And it is the same when we examine those local conditions which will have to be faced by the operator. The distension of the intestines, the difficulty of keeping them within the belly, prolong the operation, add to the shock in an exhausted patient, and by rendering asepsis most difficult, diminish his chances still farther. Another point—viz., the condition of the intestine above and below the obstruction, is a strong argument against resection and union of the intestine when obstruction is present. Above, the intestine will be distended, congested, softened; below, empty and shrunken. The difference in the size of the two sections may prove a serious difficulty in their union, but a graver objection to uniting them now is the fact that for the present both are paralysed; and though this can be met, in a measure, by emptying the contents of the upper bowel when this is cut through above the growth, yet every one familiar with these cases knows perfectly well that if the obstruction be low down it is extremely difficult to empty the bowel above sufficiently in the short time available. Much of its contents are left behind, the

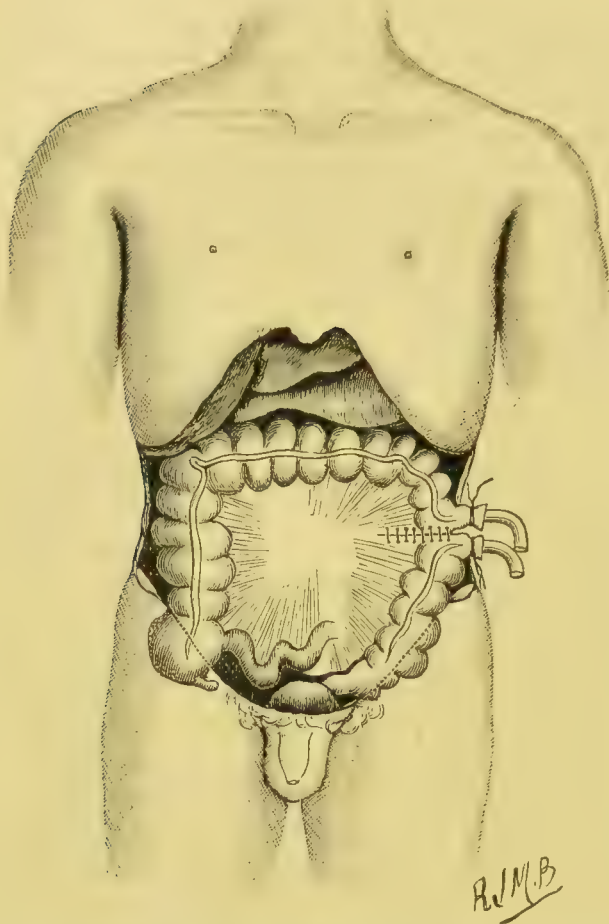
cancerous bowel was performed, 32 were of the large intestine. The parts involved were: cæcum, 7; ascending colon, 4; transverse colon, 3; descending colon, 7; sigmoid flexure 9; "colon," 2. Malignant disease is so frequent in two regions, the ileo-cæcal and the left iliac fossa that when there is any reason to suspect it an early exploratory incision should always be made.

* Quite as instructive in their way. "Nec silet mors."

† Dr. Ricketts (*Ann. of Surg.*, vol. i. 1894, p. 472), relates a case which was most favourable for resection. The growth, only of the size of a hickory nut, was easily found, drawn out, and resected. The ends were united by a Murphy's button. The ileum being enormously distended with faecal fluid, owing to the patient having deferred operation till the last, about a gallon was withdrawn by an incision, which was closed by Lembert's suture. The patient sank ten hours later.

condition of obstruction largely continues with its result—continuance of toxic absorption—and if the contents of the intestine are passed on from above, too often they find the junction of the resected parts made in softened, inflamed parts unfit to bear the strain. Where obstruction is present resection should be deferred until one of the following steps have been

FIG. 210.



Colectomy by Paul's method. Drainage of the bowel, and preparation of it for subsequent safe resection of the bowel. (Paul.)

Having cleared away any adhesions, tie the mesentery with an aneurism-needle, and divide it sufficiently to free the bowel well beyond the growth on each side. 4. Let the loop of bowel containing the growth or stricture hang out of the abdomen, and sew together the mesentery and the adjacent side of the two ends (Fig. 210). See that the stump of mesentery lies beneath the bowel, where, if deemed advisable, it can be drained by packing cyanide gauze down to it. 5. Ligature lightly a glass intestinal drainage-tube

adopted. Colotomy may be performed in the cæcum or some part of the colon, to empty the intestine and restore its tone, while at the same time the patient's strength is restored, and the surgeon chooses his own time for the performance of what is a very severe operation. Another way of performing resection in two stages is that advocated by Mr. F. T. Paul,* whose name will frequently occur in these pages, as an authority in abdominal surgery. The following are the chief steps of this operation. 1. Explore first in the middle line unless the site of the obstruction is known. 2. Make a sufficiently free incision over the site of the obstruction. 3.

* "Colectomy" (*Brit. Med. Journ.*, vol. i. 1895, p. 1136). A paper full of practical information, but especially noteworthy and admirable, nowadays, from its convincing candour. Failures are related as well as successes, and are equally instructive.

(Figs. 181 and 210) into the bowel above and below the obstruction, and then cut away the affected part. When the operation is thus performed, all the vessels except those in the primary incision are tied before they are cut, and the intra-peritonæal work is rendered bloodless. 6. The second stage of the operation, that of destroying the spur which, as will be gathered from Fig. 210, is formed by the above operation, is undertaken about three weeks later. A finger being introduced into the bowel, as a guide to each side of the spur, dressing-forceps, with the handles fastened together by india-rubber tubing, or appropriate clamp-forceps are applied to the spur, one blade on each side. These will come away within a week, and some days later the rest of the spur is destroyed in like fashion, the forceps being now applied as far as the finger makes out the spur to reach. As soon as this is satisfactorily accomplished the artificial anus is closed by separating the rosette of mucous membrane from the skin, turning it in, and bringing the freshened edge of the latter over it. Another method is to get the affected coil outside, if this be not too tied down by adhesions, keep it so by a rod, as in Reeves' method (p. 705), a Paul's tube being then tied into the upper end to drain it. Some days later, when the patient's condition admits of it, the growth is resected, and the two ends united. Mr. Lane adopted this plan successfully in a very interesting case of growth of the lower part of the ileum. A knitting-needle covered with india-rubber tubing was employed here to keep the bowel outside (*Clin. Soc. Trs.*, vol. xxvi. p. 40).

(i) **Resection of Intestine for Growths.**—The first question which arises is as to the best incision. If the surgeon is uncertain as to the exact site of the growth, he may make a median incision and clear the matter up; otherwise the incision should be made over the growth itself, either horizontally, as in an incision for appendicitis or for left-sided inguinal colotomy, or vertically, or in one *linea semilunaris*.* The variety of the incision is immaterial as long as the growth and the intestine entering and leaving it is thoroughly exposed. That the median incision is not best suited for this is shown by the number of cases recorded in which, after the operator had begun by an incision in the *linea alba*, he abandoned it, as inadequate, for one over the growth. The growth, when reached, may be covered by adherent omentum, or resemble an intussusception, appearing as a thick, rounded, firm, sausage-like swelling. When the growth is fully exposed the surgeon settles whether to attempt resection or to perform a lateral anastomosis (p. 868). Resection being decided upon, the field of operation is carefully shut off from the general peritonæal sac by flat sponges and iodoform gauze. I shall first describe a comparatively simple case—*e.g.*, resection of a limited growth of the small intestine or sigmoid, and, later, the more difficult removal of the

* Where a colotomy has been previously done, the colectomy incision may be made to run into this, vertically from above.

ileo-cæcal coil. Any adhesions present must next be divided with a blunt-pointed scissors or a dissecting tool (Fig. 211).^{*} The loop being freed is brought outside the wound, placed upon gauze or a sponge, and emptied by gentle pressure with the fingers in both directions. This being effected, clamps are applied just above and below the spots where it is decided to divide the intestine. A host of such instruments have been devised. The best are those of Mr. Makins (*St. Thomas's Hosp. Rep.*, 1884, p. 81) (Fig. 212), or a right-angled modification of them, which bear Dr. Murphy's name (Fig. 213). The blades in either case are covered by india-rubber tubing. Mr. Makins' have the advantage, that the compression exercised can be more accurately adjusted by means of a screw. Several other clamps act by perforation of the mesentery.

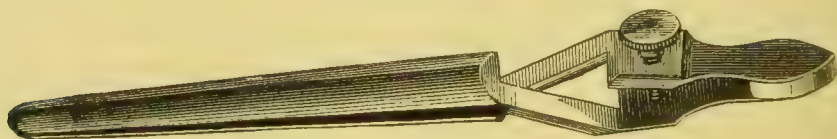
FIG. 211.



Mr. Watson
Cheyne's fine
dissector.
(Down's Cata-
logue, 1894.)

One of the simplest of these is the plan devised by the late Dr. Maunsell (*Amer. Journ. Med. Sci.*, March, 1892). A flat piece of sponge is placed over the bowel, about 4 or 6 inches from the part to be excised, and the sponge and the mesentery close to the gut are then transfixed with a strong safety-pin. The pin is again passed through the sponge on the other side of the gut and damped. The sponge should be large enough to compress the intestine against the pin, so as to effectually prevent extravasation. The advantages claimed "are its extreme simplicity, its easy applicability, its innocuousness, and its efficiency." The pressure can be regulated by the size of the sponge. Another very simple method is that of Neuber, in which a narrow elastic band is passed through a small opening made in the mesentery, close to the intestine, and tied or clamped around the gut. Others have used cords of gauze. Fig. 214 shows a clamp devised on the principle by Mr. W. A. Lane. In using any clamp which perforates the mesentery, great care must be

FIG. 212.



Mr. Makins' clamp-forceps, for use in resection of intestine. This and the next clamp should be covered with india-rubber.

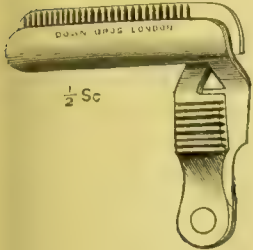
taken not to injure any vessel. This is easily managed in the case of undistended intestine, but when obstruction is present and all the small vessels enlarged, very troublesome bleeding may follow on perforating the mesentery.

^{*} The difficulty met with here varies extremely. The adhesions may be so dense as to render further operation impossible. In such a case short-circuiting should be performed. Omental adhesions are not uncommon—i.e., to the parietes, over the growth or adhesions between the omentum, and the small and large intestine contiguous to the growth.

† The late Dr. Maunsell, writing of Neuber's method (*loc. supra cit.*), says: "I have tried this method and found that the bowel may be injured by the ligature, no matter what care may be taken in applying it."

The following very simple and easily improvised clamp was used successfully by Dr. L. Rogers on a dog (*Brit. Med. Journ.*, vol. i. 1896, p. 903). The clamp consisted of a thin, flat piece of wood, pointed at one end, and having a slit at each end, through which a piece of tape could be passed. The tape, knotted at one

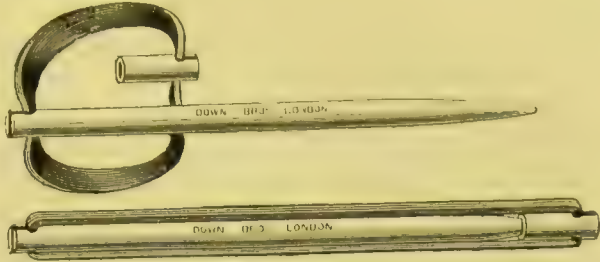
FIG. 213.



Murphy's clamp.

(Down's Catalogue, 1894.)

FIG. 214.



Lane's intestinal clamp. (Down's Catalogue, 1894.)

end, having been passed through the slit in the blunt end, the sharp end of the piece of wood was passed through the mesentery * close to the bowel, and the tape, passed over the bowel and through the other slit, was pulled sufficiently tight to compress the bowel between the piece of wood and the tape, and then fixed with artery-forceps.

Whatever form of clamp is used, if it has been long *in situ*, it may be well to shift the clamp, and to cut away the ends of the intestine which have been submitted to pressure, for fear their nutrition has suffered dangerously.

Where no clamps are obtainable an assistant's hands must be made use of. But clamps are much to be preferred; hands are more in the way, and, however willing, are liable to make more varying pressure, and to relax long before a tedious operation is completed.

If the intestine is at all distended,† it is emptied in the manner advised at footnote p. 864. The diseased mass is now resected with blunt-pointed scissors, the gut is cut across at right angles to its long axis about three-quarters of an inch beyond each clamp. If the section be made closer, the clamp will interfere with the movement of the needle in the insertion of Lembert's sutures (Treves). As a rule, the section of the intestine should be made at right angles to its long axis, and, in the present instance, resection of intestine

* Like all clamps which perforate the mesentery, this one may cause most troublesome bleeding if it injure a vein, when even the small ones are much distended—*e.g.*, when obstruction is present.

† After emptying the intestine there may still remain much difference between the ends when resected. Either the upper segment must be partially closed by a continuous and Lembert's sutures until the part left patent corresponds to the lumen of the collapsed bowel below, a step successfully adopted by Mr. Treves (*Lancet*, vol. i. 1893, p. 522), or both ends must be closed and a lateral anastomosis employed (p. 869).

for growth, the incisions should be carried onwards through the mesentery so as to remove a triangular piece with the base below at the intestine. By this means it is possible that implicated lymphatics will be removed as well. The cut vessels in the mesentery are either clamped and tied with catgut, or, where a large piece has to be removed, they can be secured before, and hæmorrhage avoided, by means of an aneurism-needle carrying catgut.

Another, but in the case of growth less desirable, way of treating the mesentery is given below (Figs. 216, 217). In either case any enlarged glands are now removed. The soiled sponges and gauze which have shut off the field of operation are next replaced by fresh ones, and the surgeon decides whether to unite the intestine by direct suture, by Murphy's button or Robson's bobbin, or to perform anastomosis of the two parts of the intestine by Senn's plates, Murphy's button or Robson's bobbin, *q. v.*

With regard to the details of the steps adopted in the more difficult operation of resection of the ileo-cæcal coil, I shall quote from a very helpful report of a case by Mr. Lowson, of Hull (*Lancet*, vol. i. 1893, p. 618):

The abdomen having been opened by an incision in the right linea semilunaris, the omentum was found adherent to the tumour anteriorly, and detached after ligature. "Pushing the colon inwards," I now entered the scissors above the level of the tumour, through the peritoneum lining the posterior wall of the abdomen, to the outer side of the great bowel, and ran it down to a point opposite the lower end of the cæcum. The bowel could now be easily separated from its bed. It still remained to divide the peritonæum on the inner side where the colic vessels spread out, fan like, to supply the colon. This was done by tying the serous membrane with the vessels in five or six successive pieces, and dividing between the ligatures and colon. The line of this incision inclined downwards and inwards meeting the ileum as it crossed to join the colon five or six inches from the ileo-cæcal valve. Several diseased glands were included in this triangle. The ileum was separated from the mesentery in the same way, and now the greater part of the ascending colon, with the cæcum and four or five inches of the ileum, were free along with the tumour. The time had now arrived for dividing the bowel. Two long Makins' clamps were applied to the colon above the tumour, and between these the bowel was divided as nearly at right angles as possible. The ileum having been divided, and the diseased portions removed, the ends of the intestine were closed by fine continuous sutures and turned in by Lembert's sutures. Lateral anastomosis was performed by means of Senn's plates. Mr. Lowson draws attention to one detail, which, as he says, "cannot be neglected without fatal extravasation—*i.e.*, to be especially particular to bring the serous surfaces accurately in apposition at the point where the mesentery joins the intestine, and where the serous coat of the mesentery is deficient behind." The patient, aged thirty-three, made a good recovery, and, thirteen months later, there was no perceptible recurrence.

* In Mr. Treves' case (*loc. supra cit.*), seven inches of the sigmoid flexure were removed successfully for a cylindrical epithelioma. In another successful case Mr. K. Franks removed five inches of the transverse colon for a similar growth. The ends were united by Lembert's sutures (*Lancet*, vol. i. 1893, p. 1387).

(ii) **Resection of Intestine for Gangrenous Hernia.*** This, the second most frequent indication for resection, must be treated separately. The operation has now to be undertaken under different conditions to that under which removal of a new growth is performed. We have seen (p. 855) that then it is always best to defer resection of the intestine, if possible, until obstruction has passed away under medical treatment, or has been met by a colotomy, the surgeon choosing his time until the patient's general condition of strength and nutrition, and the local state of the bowel, are alike rendered as favourable as may be for meeting the calls of a severe plastic operation. In resection for gangrenous hernia, the conditions both of the patient and the intestine to be operated on are very different. Before describing the actual operation I would say that no absolute rules can be laid down here. Relief of a strangulated hernia is one of those operations of emergency, sometimes admitting of no delay, which any general practitioner must undertake, often under very unfavourable surroundings. It would be most unfair to expect that such a man, when face to face with a gangrenous hernia, should meet it in the same way as a hospital surgeon, able to command the very best surroundings, abundant help, and himself experienced in intestinal surgery. As I have said at p. 634, when the condition of the patient, the experience of the operator and his surroundings admit of his taking this step, resection of the gangrenous intestine should always be performed. Where the above conditions are absent, the operator must rest content with enlarging the wound,† drawing all the gangrenous intestine well outside the peritonæal sac, opening and draining it thoroughly, by one of the means given at p. 781. This will avoid the terrible risks of a continuance of paralysis of the bowel, stercoraceous vomiting, exhaustion, or toxæmia. The loop must be kept outside by a sterilised bougie or glass rod as in inguinal colotomy (p. 705), aided by a few sutures. Any gangrenous omentum must be removed, and the sac cleansed as far as possible.

Operation.—The intestine being found to be gangrenous, the extent of this must be first made out. It is possible that in a few cases the mischief may be so circumscribed as to involve only part of the circumference of the bowel. Here the resection

* The following are some of the most useful papers on this subject. Lockwood (*Med. Chir. Trans.*, vols. lxxiv. and lxxvii.), W. A. Lane (*Clin. Soc. Trans.*, vol. xxiv. p. 102), McCosh (three cases treated successfully by circular enterorrhaphy), (*Ann. of Surg.*, vol. i. 1894, 647). Ransohoff (*ibid.* vol. 1892); Mikulicz, (*Berl. klin. Woch.*, Nov. 10, 1892); Riedel (*Deut. Med. Woch.*, 1883, No. 45); Reichel, (*Deut. Med. Woch.*, 1883, No. 45); Zeidler, (*Centr. f. Chir.*, Jan. 16, 1893, p. 62); Caird (*Edin. Med. Journ.*, 1895, p. 312), a very interesting paper, in which eight cases of resection and suture of the intestine are given, with three deaths, one of these being due to bronchitis and pulmonary œdema.

† In a very few cases, where the surroundings are even more unfavourable, the operator may have to be content with simply opening the bowel and doing no more (p. 634).

of a very small portion of bowel is required, while in some it may prove sufficient merely to invert and suture the margin of the aperture, and it is possible to accomplish this through the original wound. Successful cases of partial resection are recorded by Sachs (*Deut. Zeits. f. Chir.*, Bd. xxxii. S. 93); Barette (*Thèse de Paris*, 1883, "De l'Intervention Chirurgicale dans les Hernies"); Lindner (*Ber. Klin. Woch.*, 1891, p. 277). One or two cases have also been recorded in America, but such circumscribed mischief is very rarely met with, and where such limited resection is practised, care must be taken to place the sutures in healthy tissues. Five cases of partial gangrene of the intestine treated by inversion of the gangrenous or ruptured portion are very briefly given in an instructive but very short paper by Mr. Caird, *Ed. Med. Journ.*, 1895, p. 312:

All five were cases of hernia. There was a "perforation" of the intestine in one, and a "rupture" in two. Of the five cases, three recovered. Of the two which died one was an infant aged eighteen months. The autopsy shewed firm union of the intestine without peritonitis. "The intestine was beset with typhoid ulcers of ten or fourteen days' duration."

The following is Mr. Caird's advice as to the treatment of gangrenous intestine by inversion, and the cases suitable to this method. "If we meet with the typical elliptical necrosis of the bowel which runs longitudinally opposite the mesenteric attachment, we may, with Lembert's sutures, stitch the sound tissues over the unhealthy, thus inverting the gangrenous area into the lumen. This practice, which obviates the necessity of cutting any part of the bowel away and requires no special dexterity, is in all probability not applicable with safety where more than one third of the circumference is destroyed. The fear of stricture ensuing rather determines us to resect in such cases. . . . The method of inversion, although easy, cannot be modified to meet the exigencies of every case. It does not lend itself to these instances in which the gut is almost completely divided by the tight grasp of a narrow femoral ring. The vitality of the proximal end has then been too severely tried to admit of such an experiment. We should require to invaginate a few inches of the damaged gut before we come upon healthy tissue to suture; and since it is impracticable to reproduce the successful natural cure occasionally seen in cases of intussusception, we are driven to resect." If inversion be made use of, the greatest care must be taken, as in partial or complete resection, to ensure that the sutures lie in healthy tissues.

Far commoner conditions are: (1) Where a whole loop or knuckle is gangrenous; (2) while the loop may appear fairly healthy at its neck (where the pressure has been exerted) one or two pressure-furrows or lines of ulceration are present, the greatest care must be taken in drawing this part of the bowel down, or its contents may escape into the peritonæal sac. (3) The gangrene extends over the convexity of the loop. In these last three

resection will be freely required, passing through healthy tissues.

The first question that arises when resection is determined upon is whether we should carry it out through the original wound, enlarged, or through a second in the linea alba. The answer to this must depend mainly upon the variety of the hernia and the means adopted for uniting the resected ends. Where union by suturing is adopted, or a contrivance of no great size such as Mr. M. Robson's bobbin is employed, the wound, especially in a femoral or umbilical hernia, will simply need enlarging freely.

FIG. 215.



Two different ways of dealing with the mesentery in resection of the intestine are here shown. In one the bowel is detached from the mesentery a little above their junction, all bleeding points being carefully tied, or the two folds of the mesentery united with a fine continuous suture. The dotted outline of the wedge shows the other mode of dealing with the mesentery. Drainage tubes are used as clamps. (Esmarch and Kowalzig.)

FIG. 216.



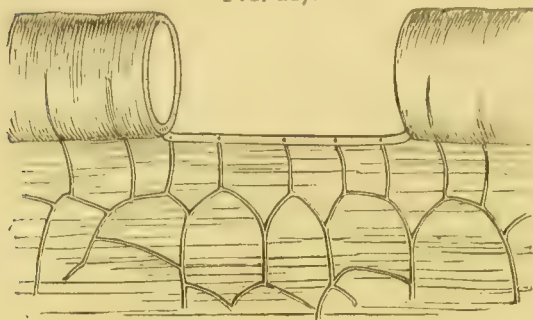
Here the resected ends are shown sutured, and the edges of the redundant fold of mesentery which is present where no wedge is removed are being united with a continuous suture. Note that here and in Fig. 218 the union of the bowel and the mesentery is continuous across the triangular interval at the junction of the two. (Esmarch and Kowalzig.)

Where larger foreign bodies, such as Senn's plates, are employed, it may be wiser to employ a fresh incision in the linea alba.* This will of course run the risk of contamination of the peritonæal sac, and call for every precaution for preventing it. Any gangrenous or septic omentum having been tied and removed, the sac and gangrenous intestine carefully cleansed with perchloride lotion (1 in 5000), any opening on the bowel is temporarily but securely closed. An incision having been made below the umbilicus in the linea alba, the damaged loop is drawn out of the abdomen through this wound. Owing to the additional time

* Mr. W. A. Lane made use of this method in two cases in which he resected gangrenous hernia, and united the intestine by means of Senn's plates and lateral anastomosis (Fig. 225). One patient made a good recovery, the other, whose condition was very grave at the time of operation, died on the fifth day, and the autopsy showed a perforated gangrenous patch on the upper piece of the intestine (*Clin. Soc. Trans.*, vol. xxiv. p. 182).

taken by this fresh incision, the risk of contaminating the peritonæal sac, and the fact that now, when the resected ends can

FIG. 217.



A piece of intestine has been resected without removing any mesentery. (MacCormac.)

be safely united by suture alone, or by a small body such as M. Robson's bobbin, we can dispense with such large bodies as Senn's plates, it will be better to perform the resection through the original wound, which must be prolonged upwards in a femoral hernia, dividing Poupart's ligament, upwards or downwards in an umbilical, and upwards along the linea semilunaris in an in-

guinal hernia. The damaged loop having been drawn well out, the peritonæal sac is shut off with gauze and sponges and clamps applied as advised at p. 858, care being taken to get well above the inflamed parts, and so to secure speedy and sound plastic union. The intestine to be sacrificed is now cut away, care being taken to remove too much rather than too little.* The only rule here must be to remove every atom of suspicious bowel, and to cut through and place the sutures in healthy tissues.† It would seem from published cases that the mesentery may with equal success be treated as in Fig. 215, by excision of a wedge,‡ or differently as

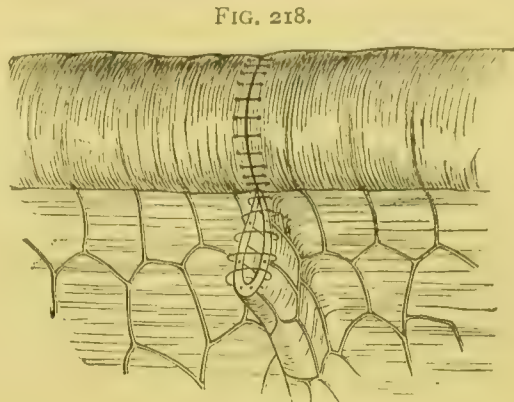
* We find in many of the fatal cases reported, that the cause of death was attributed to gangrene spreading upwards above the seat of suture. On the other hand, we find that recovery has followed when large portions of the intestine have been removed. Thus, Ramdohr excised 2 feet; Rydiggier had a case in which 54 centimetres were sacrificed; Rushton Parker cut out 12 inches. Walter also removed 2 feet 4 inches; and lastly Kocher, had a patient who left the hospital perfectly well on the eighteenth day, after having had about 5½ feet of intestine removed. All these patients recovered (Kendal Franks, *loc. supra cit.*).

† Lockwood gives the useful hint to cut through the collapsed distal end first, as the gangrenous portion and the distended end may then be drawn further from the wound, and used as a spout to carry off the fæcal accumulation (*Med. Chir. Trans.*, vol. lxxiv. p. 213). Caird (*Edin. Med. Journ.*, vol. ii. 1895, p. 314) advises thus on this point: The peritonæum being well shut off, "just beyond the distal end of the gangrenous mass a couple of long-bladed pressure-forceps should be applied side by side, and the gut completely divided between them. The mesentery should now be severed along its attachment to the portion of gut we wish to remove, and this enables us to hold the free extremity over a vessel, when, on removing the forceps, the contents escape and the congestion abates. Having thus relieved the congestion and emptied the gut we may now reapply the forceps on the central healthy gut, and cut away the intervening damaged portion." Mr. Caird considers that if the pressure forceps have inflicted any permanent damage on the cut margin of the gut that edge becomes inverted, thanks to the Lembert's sutures (*vide infra.*).

‡ Lockwood (*ibid.*) condemns the removal of a wedge. "Although desirable,

in Figs. 215, 217. In this latter case the mesentery is divided just as close to the bowel as possible.

The ends having been resected, the intestine above emptied, cleansed, and the clamp above reapplied, the operator must decide on his mode of uniting the resected ends. All the following have been used successfully: Circular suture, M. Robson's or some other bobbins, Murphy's button, Paul's tube, Senn's plates. I believe that in the future one of the two first, for reasons given at p. 853, will prove the safest, and score most successes. If suture be relied upon, the method given at p. 830, of a continuous internal suture applied after Hagedorn's method, and an external on Lembert's



The intestine has been sutured and the mesentery appears as a redundant fold whose edges have been united by a continuous suture. (MacCormac.) Sir William considered that this method of dealing with the mesentery would obviate to a large extent the risk of gangrene of the bowel.

plan, or that which Mr. Caird advises (pp. 829, 830), should be employed. The future will probably show that a single continuous suture on Lembert's plan will suffice, provided that sufficient inversion is proved, and that the junction of the intestine and mesentery is duly secured. A few supplementary sutures can easily be added at any spot which appears weak. The clamps having been removed, the bowel, cleansed and dusted with iodoform, is returned; the upper part of the wound is next closed with deep sutures, the lowest of which should obliterate the neck of the sac. Poupart's ligament, if divided, must be united by buried sutures. As the sac will almost certainly have been septic, a drainage tube should be employed.

The question of the advisability of attempting a radical cure now arises. Very often this will be forbidden by the general condition of the patient. Whenever there is any risk of septic infection, or any doubt as to the efficiency of the suture, the

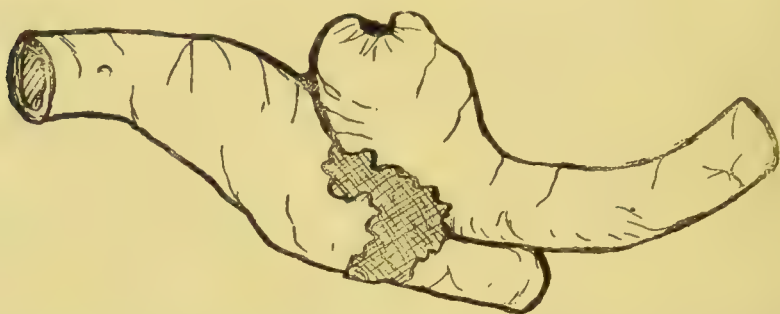
perhaps, on theoretical grounds, it leads to so much hæmorrhage and loss of time that the advantages are outweighed by the disadvantages." In his successful case (*loc. supra cit.*, vol. lxxvii. p. 196) "None of the mesentery required excision, and the gap left in it by the removal of the bowel was closed with a few points of suture. Ransohoff, in his successful case (*loc. supra cit.*), did not remove a wedge. Mr. Caird (*loc. supra cit.*) writes: "Where the gut has not given way it is not necessary to remove any of the mesentery. As Kocher has indicated, it suffices to suture the free margins to each other. This checks the small amount of hæmorrhage usually present, and serves to approximate the severed ends of intestine. If, however, the mesentery has been in contact with faecal matter, it is better to remove entirely the contaminated triangular portion."

wound must be kept open. Mikulicz, if I understand him rightly (*loc. supra cit.*), leaves these cases open.

If any extravasation have taken place into the peritonæal sac, this must be cleansed, and drainage employed as advised at pp. 809, 818.

It may be convenient to briefly recapitulate here the chief courses open in the treatment of gangrenous hernia. (1) Leaving things alone (p. 634); a course only to be adopted when the condition of the patient and the surroundings of the surgeon do not admit of more being done. (2) Primary resection either of a portion of a coil, as in a gun-shot wound, or more usually of the whole loop. (3) Intermediate resection (Riedel, *Deut. Med. Woch.*, 1883, No. 45). Resection is performed, an artificial anus established, and after twenty-four or forty-eight hours the edges of the intestine are vivified and united by suture. (4) Enterostomy or the making of

FIG. 219.



Ileo-ileostomy with Senn's plates, completed. An omental graft has been placed over the line of union. From a specimen removed from a dog some time after recovery. (Jessett.)

an artificial anus and the closure of this at a subsequent date. In cases where the collapse of the patient demands prompt termination of the operation, the surgeon should insert two Paul's tubes in the ends of the intestine, keeping these well outside (Fig. 210). The spur and the artificial anus must be closed later on (p. 857). (5) If an unfavourable change take place in the patient's condition, before the surgeon has time to complete the suturing to his satisfaction, he may adopt Bouilly's mixed method (*Rév. de Chir.*, 1883). The ends of the intestine are sutured together by Lembert's method, with the exception of a small opening on the convex border, opposite its mesenteric attachment, where a small opening is left. The edges of this are sutured to the abdominal wound, a fæcal fistula being thus formed, which Bonilly maintains will shortly close. In any case in which I was not satisfied as to the completeness and efficacy of the sutures, I should prefer to place the sutured bowel just within the abdomen, and pack it round with iodoform gauze to shut off the peritonæal sac until union is assured. In twenty-four or thirty-six hours it will be safe to remove the gauze and to close the wound by means

of provisional sutures inserted at the time of the operation. Or the following precaution may be adopted.

Omental Grafting (Figs. 219, 220, & 221).—This is one of those details in intestinal surgery which we owe to Senn. To strengthen

FIG. 220.



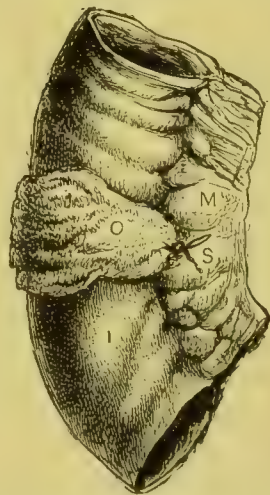
Ileo-colostomy. The line of implantation of the small into the large intestine has been covered with an omental graft. From a specimen removed from a dog some time after recovery. (Jessett.)

a weak spot or line of union a strip of omentum is torn, not *cut*, from the free end of the omentum, laid over the spot which it is intended to strengthen and secured with a few sutures. The contiguous surfaces may first be lightly scarified, short of causing bleeding. Another method, that of leaving the graft attached by one end, should not be adopted, as this may, later, bring about ill results in the form of intestinal obstruction.

In the after-treatment of resection cases collapse must be vigorously combated, feeding by the bowel trusted to for thirty-six or forty-eight hours, and as little morphine or opium given as possible, for fear of "conducting to further, and perhaps fatal, intestinal paralysis," (Lockwood). Flatus will probably be passed in forty-eight hours and the bowels act between the fourth and sixth days.

Treatment of intestine which is dangerous though not actually gangrenous.—Before leaving the subject of gangrenous intestine in hernia, and its treatment, there is one remaining allied class of hernia often very fatal, for which modern surgery may do much, viz., that in which the condition of the bowel is such that, though gangrene is not yet present, this condition may set in

FIG. 221.



An omental graft secured in place over the line of an enterorrhaphy. I. Intestine. M. Mesentery. O. Graft. S. Suture fixing graft. (Walsham.)

if the bowel be returned into the abdomen. In Ransohoff's words (*loc. supra cit.*, *Ann. of Surg.*, vol. ii. 1892, p. 349). "Such a knuckle is a menace. Bowel that is not at all doubtful in appearance will at times repay the trust placed in it by a perforation. Among 96 deaths after herniotomy it was, in 26 cases, the result of returning intestine which subsequently perforated. To return doubtful intestine is necessarily jeopardising life. To treat such intestine as radically as bowel already gangrenous is an extreme measure not to be advocated. Fortunately the intestine can be retained in the wound for a number of days in gauze packing or by sutures. When its viability has been established it is an easy matter to return it into the abdomen."

Graefe has reported (*Deut. Zeits. f. Chir.*, Bd. xxxiv. p. 82) a successful case in which the intestine was so retained for five days before it was replaced.

While I entirely agree with Dr. Ransohoff in the principle of the above, I think he represents the returning of such intestine as unduly easy. Even after twenty-four or thirty-six hours, the earliest date at which it will be safe to return it, the intestine will be found adherent to the gauze and to bleed easily.

INTESTINAL ANASTOMOSIS. SHORT CIRCUITING. LATERAL ANASTOMOSIS.

The first two of the above-given terms have been often needlessly used for the same thing—viz., the establishment of a permanent fistulous opening between the bowel above and the bowel below some point of obstruction, usually a growth which cannot be removed.

By Lateral Anastomosis is meant the making of a fistulous opening between two parts of resected intestines, the two ends being first securely closed.

However end-to-end junction of resected intestine may ultimately be performed, it is certain that the above operations have a great future before them. The principle of them all, and the making them of practical utility, we owe to the labours and experiments of Prof. Senn.

Indications.—Intestinal anastomosis or short circuiting are to replace resection where the general and local conditions forbid the severer step in such cases as (a) growths; for cases suitable for resection see p. 854. (β) contraction, cicatricial and not malignant in character. (γ) Matting of intestines by old mischief, perhaps dating to tubercular peritonitis, or inflammation about a caseous mesenteric gland, (δ) an intussusception which is irreducible but not gangrenous.

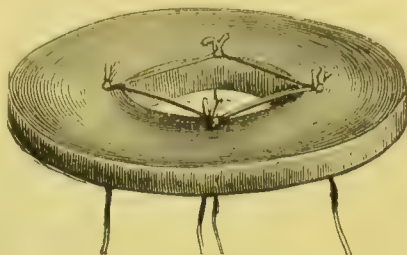
Advantages.—Prof. Senn claims the following, and with regard to the principle of intestinal anastomosis all will agree with him. As to the details whether his method is the best, time alone will show. (1) That the operation can be rapidly performed with a great saving of time. (2) That the junction of the intestinal surfaces around the anastomosis is a safe one. (3) That the

operation is independent of any difference in the size of the bowel above and below the obstruction. (4) That the principle is of very wide application. The objections are given at p. 849.

Operation. (i.) With Senn's plates. These were substituted for sutures by their ingenious author with the object of (a) saving time, (b) doing away with the evils of numerous sutures, (c) of securing a wider approximation of serous surfaces, and a more complete rest for the parts to be united. The decalcified bone plates, each with the four sutures,* two above and below at the ends, and two at the sides, are well known (Fig. 222).

As an instance of this operation we will take ileo-colostomy or anastomosis of the ileum and ascending colon, when a carcinoma of the cæcum—a common instance of malignant disease of the intestine—is found not to admit of removal. An incision having been made over the mass, horizontally or vertically, or in the right linea semilunaris, as advised at p. 857, a suitable piece of the ileum and the ascending colon† are if possible brought into the wound. If this cannot be effected the pieces of bowel chosen, and area of operation, must be most carefully packed off with iodoform gauze or sponges.‡ The parts which are to be joined by anastomosis having been brought outside they are laid on a flat but aseptic sponge, and gently emptied with the fingers, and kept so with clamps of some kind (p. 858.) If the upper end be much distended the opening for the plate is made at once. An incision about $1\frac{1}{2}$ inch long§

FIG. 222.



A Senn's decalcified bone plate ready for use. When the first threads have been passed they should be secured to the back of the plate and to each other by another thread passing between each as in the figure. The plates should be kept in a solution of equal parts of alcohol, glycerine, and water, being placed in 1-40 carbolic acid lotion before use. They are on no account to be inserted dry, owing to the certainty of their swelling and causing tension, sloughing, &c. (Walsham.)

* If the plates are not threaded this can be quickly done by passing two round needles, carrying about 24 inches of silk from before backwards, through one end perforation, and then from behind, forwards through one lateral perforation. The needles are cut away and the four ends knotted (Fig. 222).

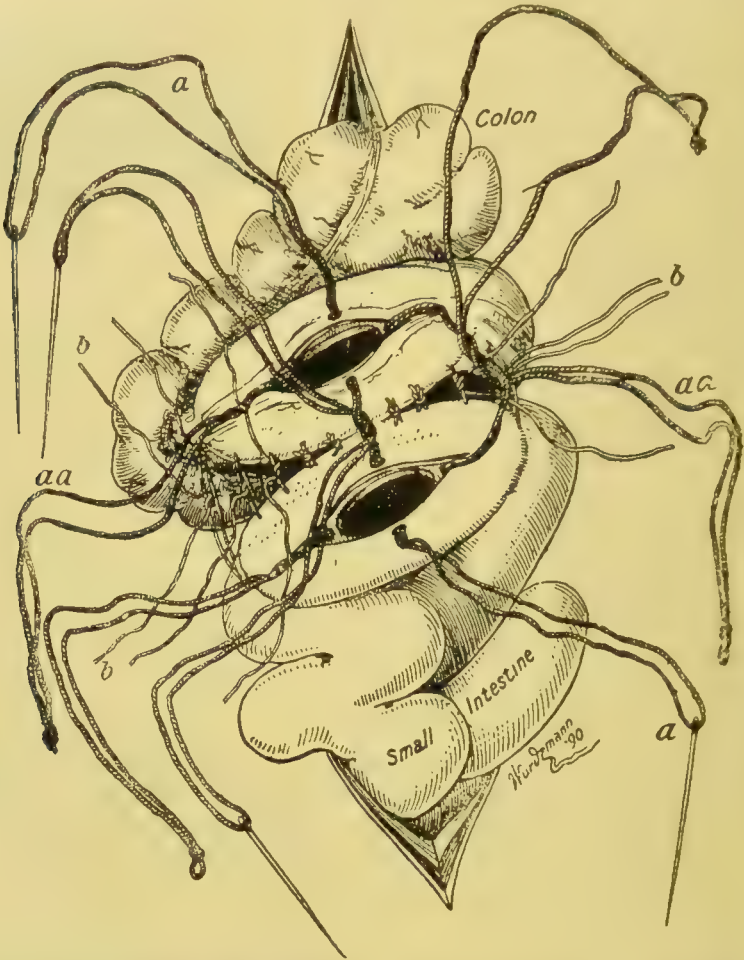
† In Mr. Treves' words (*Operative Surgery*, vol. ii. p. 340), these two parts of bowel "should not be so far distant from one another as to exclude a large tract of intestine after the operation is complete, nor so near as to expose the actual area of disease, or to render the manipulation of the parts difficult. It is probable that the upper coil will be distended and hypertrophied, and the lower empty and wasted."

‡ I prefer both in a case of this kind: flat sponges (held by Spencer-Wells forceps) pushed well into the abdomen to keep the small intestine, &c., back, and over these, tampons of iodoform gauze lining the edges of the wound.

§ If the opening be too small, force will have to be employed in inserting the tube, and bruising will follow: if too large, the plates may escape or ride loosely after the sutures have been tied.

is made in the long axis of the ileum on its free border, and the contents allowed to escape where they can do no harm. Any free bleeding from the incision will yield to forcible pressure without ligature. If there be plenty of time it will be well, as advised by Mr. Jessett, to run a continuous suture around each opening, (Fig. 229); this will arrest any bleeding, and prevent the

FIG. 223.



Intestinal anastomosis—ileo-colostomy—with Senn's plates. These have not yet been approximated. The cæcum here has not been resected. Cf. with Fig. 226. *a, a*. Lateral transfixion or fixation sutures passed through the intestine. *aa, aa*. End or apposition sutures hanging out of the wound. *b, b*. Posterior or row of Lembert's sutures. (Jessett, from Senn.)

closure of the wound and prolapsing of the mucous membrane (p. 874). The lumen of the opened intestine, as far as it can be reached, having been cleansed with pledgets of aseptic wool, a bone plate (Fig. 222), threaded, is inserted edge-ways, and when it is completely within the lumen of the bowel, traction is so made on the sutures as to bring the plate with its threaded surface upwards in the wound, and with its central opening accurately placed with reference to the opening in the intestine (Fig. 223).

The plate is then fixed in this position by transfixing the wall

of the bowel near the edges of the opening, and at spots equidistant from its angles with the lateral sutures (*aa*, Fig. 223). The end sutures hang out of the upper and lower angles of the wound, (*aa, aa*, Fig. 223). A longitudinal incision is next made in the colon opposite to the mesocolon, well above the disease, and a bone plate introduced here with precautions similar to those already given.

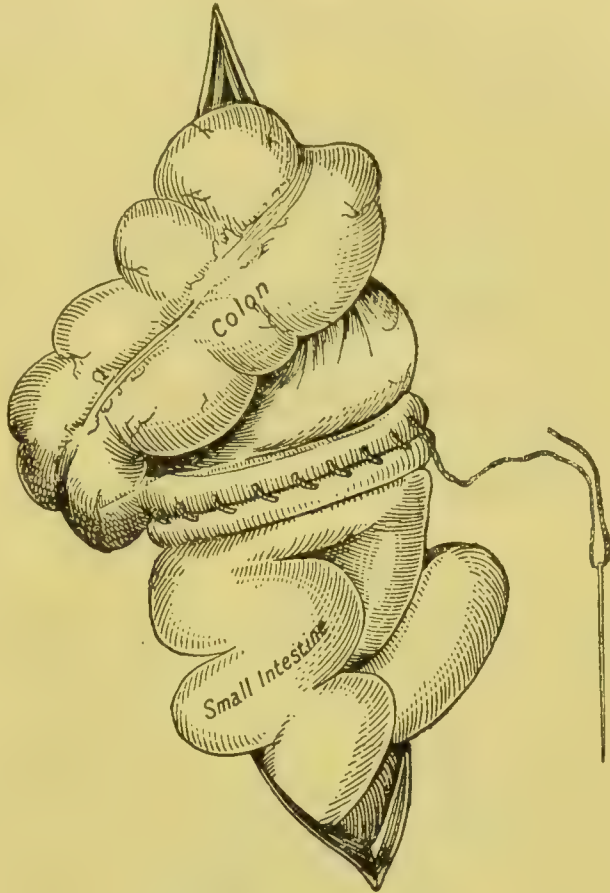
The peritonæum covering each plate is now lightly scarified with numerous cross lines made by a needle, but not deep enough to cause bleeding, and the serous coats where these are in contact along the posterior margins of the plates are united with a few superficial sutures (Fig. 223).

The plates being now held in accurate apposition by an assistant, the threads which have previously been identified are tied in the following order, first, the inner lateral sutures (these are shown in process of tying Fig. 223). Next the pair of end threads which are farthest from the operator are tied, and then the opposite pair. In tying these, the

threads must be drawn down between the plates. Finally the only remaining or the outer lateral threads are tied. In tying each of the four pairs, sufficient force only must be used to bring and keep the plates together, and to ensure firm knots. All that now remains is to reinforce the threads which have been tied by running together the serous surfaces along the anterior margins of the plates by a few points of sutures, or a continuous one (Fig. 224).

The parts are now carefully cleansed, the clamps removed, the flat sponges and gauze tampons removed, and the peritonæal sac having been cleansed of any blood clot, &c., a little iodoform

FIG. 224.



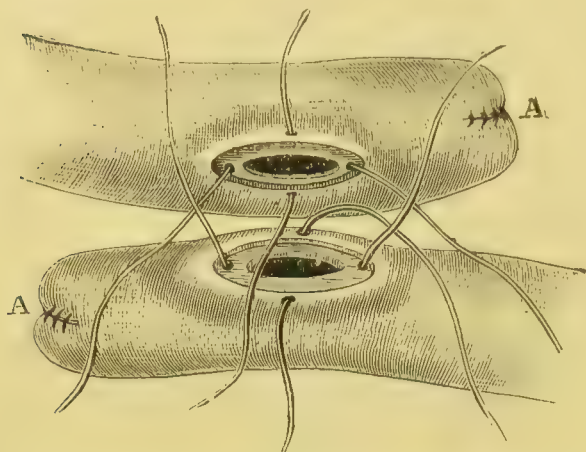
Intestinal anastomosis—ileo-colostomy—with Senn's plates. These are now approximated and the anterior row of sutures is being applied. The cæcum here has not been resected. Cf. with Fig. 226. (Jessett, after Senn.)

is rubbed along the lines of sutures in the intestines operated on, and these are returned. The wound is then closed in the usual way.

Anastomosis with Senn's plates after excision of the cæcum.

Intestinal anastomosis, *e.g.*, ileo-colostomy in cases where removal of the ileo-cæcal coil was impossible, having been described, we shall next imagine a case where it has been possible to remove the bowel, but the surgeon prefers to unite the ends by lateral anastomosis instead of end-to-end union. The account is Prof. Senn's (*Journ. Amer. Med. Assoc.*, June 14, 1890): "After all

FIG. 225.



Intestinal anastomosis by Senn's plates after complete resection of a part of the small intestine. The ends have been closed by a continuous Lembert's suture. (Walsham.)

hæmorrhage had been carefully arrested both resected ends were closed by invagination and a few stitches of the continuous suture (*a*, Fig. 226). The first stitch was made to transfix the mesentery at the point where it was invaginated into the bowel. Medium-sized perforated decalcified bone plates were used in making the ileo-colostomy by lateral approximation. An incision about two inches in length was

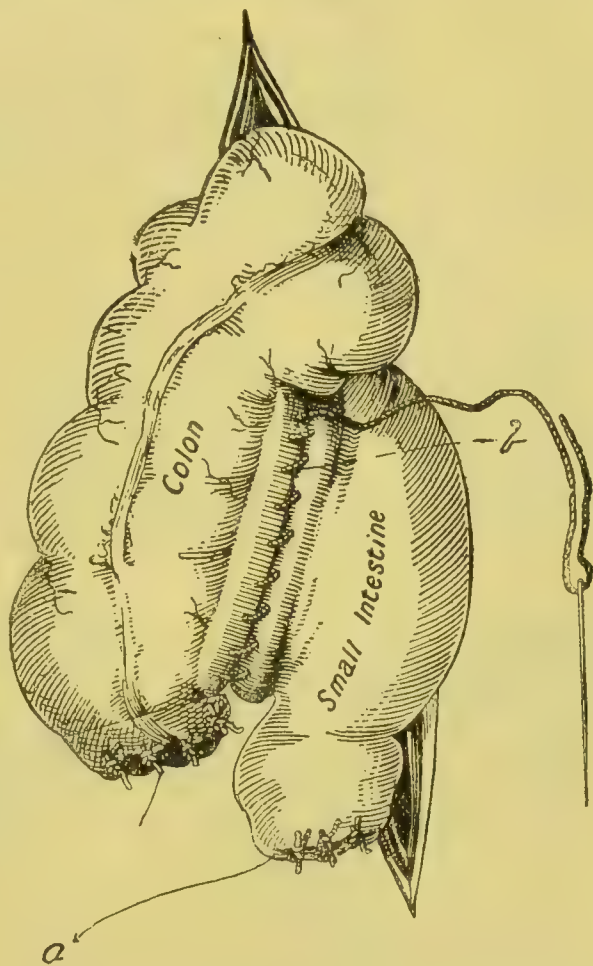
made in the closed ends of both intestines at a point opposite the mesenteric attachment, and into each opening a bone plate was inserted, and the lateral sutures, armed with a needle, were passed about an eighth of an inch from the margin of the wound at a point half-way between the angles of the intestinal wound. The margins of the bowel corresponding to the parts covering the plates were freely scarified with an ordinary sewing-needle. The visceral wounds were now brought *vis-a-vis* in such a manner that both closed ends were directed downwards, bringing in this manner the free surface of the colon and ileum together. Before any of the plate-sutures were tied, a number of Lembert sutures were applied posteriorly, sufficiently far back so that after the approximation they should be just beyond the borders of the plates, thus affording sufficient security in maintaining co-aptation. The posterior pair of transfixion sutures* were now tied, after which both pairs of the sutures not armed with needles were tied. During the tying of these sutures, it is of the greatest importance that an assistant should keep the plates accurately and closely pressed together. The last sutures to be tied were

* The two seen tied between the two plates in Fig. 223.

the second pair of fixation sutures; and as this was being done, the bowel on each side was carefully pushed in between the plates with a probe. The sutures were tied in a square knot, and only with sufficient firmness to bring the parts in apposition, as any undue pressure would have been detrimental and might have resulted in gangrene of the tissues included between the plates. The sutures were cut short, and the ends brought as near the opening as possible, by pushing them in this direction with a probe. After all the approximation sutures were tied, it only remained to apply in the upper side a few Lembert sutures or a continuous one (*c*, Fig. 226) in the same manner as was done on the opposite side before any of the approximation sutures were tied."

FIG. 226.

Mr. Littlewood of Leeds has suggested (*Lancet*, vol. i. 1892, p. 866) a **modification of Senn's plates**, with the object of (1) doing away with the sutures, some of which perforate the whole thickness of the bowel, and thus may introduce sepsis; (2) of performing the operation more quickly; (3) of ensuring a good opening between the two viscera. The suggested modification is that by means of a decalcified bone tube fixed in its opening, one plate fits accurately into the aperture of the other. By this means it is thought that the two plates would be held together, while the two visceral walls between them would be brought evenly in contact with each other.



Intestinal anastomosis—ileo-colostomy—with Senn's plates. The cæcum here has been resected. Cf. with Figs. 223 and 224. *a*. Closed ends of ileum and colon. *b*. A continuous suture uniting the serous surfaces over the anterior margins of the plates. (Jessett, after Senn.)

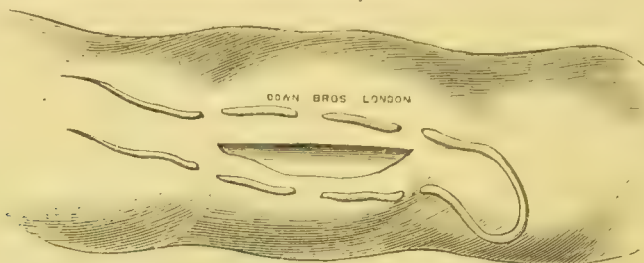
II. Lateral Anastomosis with Murphy's Button (Fig. 227).

—The technique here differs but little from that already given for end to end junction by this method. Similar spots in the ileum

and cæcum having been chosen, a needle with about a foot of silk is inserted in the long axis of the bowel as at Fig. 227; a stitch is taken through the entire wall of the bowel, one-third the length of the incision to be made; the needle is again inserted

one-third the length of the incision from its outlet, in a line with the first, and embracing the same amount of tissue. A loop 3 inches long is held here, and the needle is inserted in a similar manner, making two stitches parallel to the first in the reverse direction and one-fourth of an inch from it, coming out at a point near the original insertion of the needle. This forms the running thread (Fig. 227) which, when tightened, draws the incised edge of the bowel within the cup of the button. A similar running thread

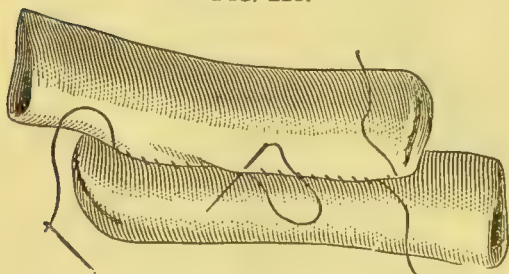
FIG. 227.



This shows the method of passing the puckering thread when Murphy's button is used in lateral intestinal anastomosis, gastro-enterostomy, etc. (Down's Catalogue, 1895.)

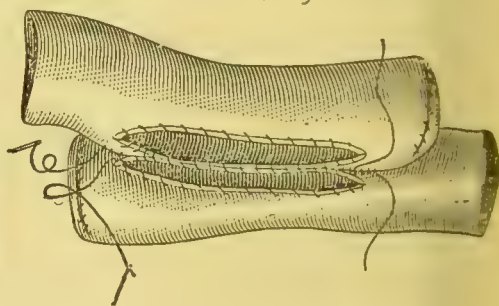
is inserted in like fashion in the colon. Incisions two-thirds the length of the diameter of the button to be used are then made between the two running threads (Fig. 227), care being taken not to cut these, the female half of the button slipped into the ileum and the male into the colon, the running thread drawn tight and tied firmly round the central cylinders. While this is done, an assistant holds each half in place, and care is taken that the intestine is held evenly all round the cylinder in the grip of the ligature.

FIG. 228.



Abbe's method of anastomosis by sutures only. To show the suturing of the intestines before the incision is made. (*American Text-book of Surgery.*)

FIG. 229.



To show the four-inch openings and the sewing of the edges. (*American Text-book of Surgery.*)

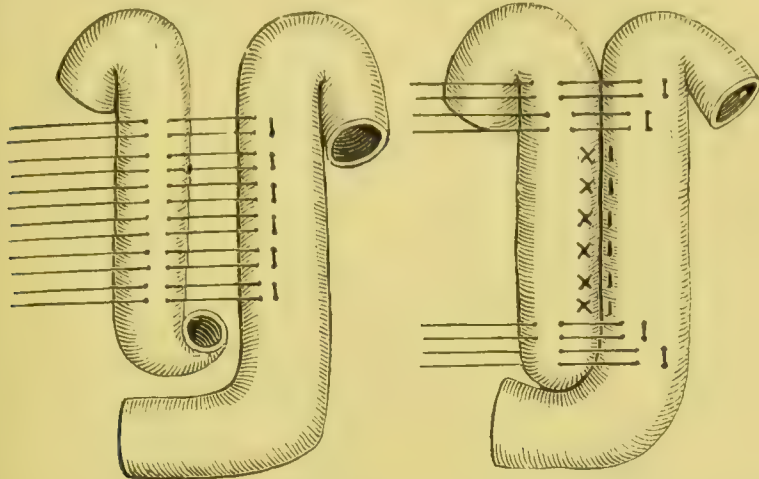
The two halves of the button, next held in the fingers, are firmly pressed together (Fig. 267) until the serous surfaces are in accurate contact all round and at every point.

Lateral Anastomosis by Sutures alone (Figs. 228-231). Some of the best American surgeons are abandoning artificial aids in anastomosis and preferring to trust to sutures alone, just as in end-to-end union they have returned to circular enterorrhaphy (p. 854). The method of Abbe, which has given good results, is as follows:

after resection of the intestine and closure of the two ends, the two segments of intestine are laid parallel with each other, and two rows of continuous Lembert's sutures are applied a quarter of an inch apart and an inch longer than the incision which it is proposed to make (Fig. 228). Each piece of silk (24 inches long)

FIG. 230.

Fig. 231.

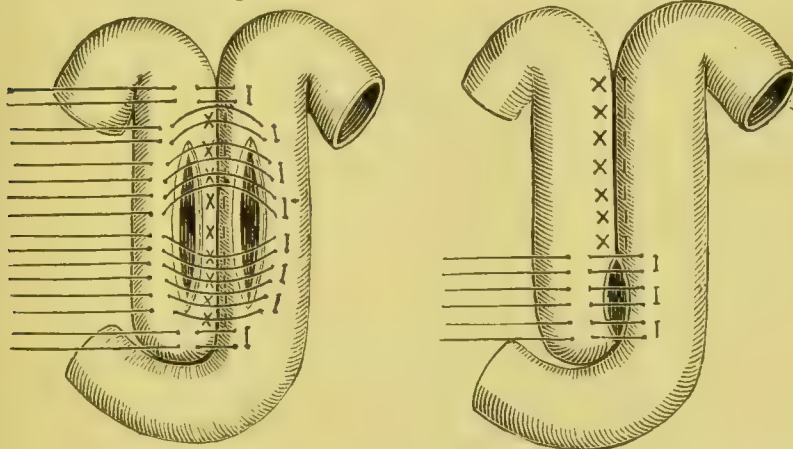


Method of lateral anastomosis by Halstead's simple suturing. The sutures are of the square kind. Fig. 230. First stage. Fig. 231. Second stage. (Jessett, from Halstead.)

is left at the end of its row, being still threaded. The bowel is then opened for four inches a quarter of an inch from the sutures, both rows being to one side of the cut. Any vessels that bleed are treated by forcipressure. The opposite segment of bowel is

FIG. 232.

Fig. 233.



Halstead's operation, third and fourth stages. (Jessett, from Halstead.)

then opened in the same way. The two adjacent cut edges are now united by a suture which traverses both the mucous and serous wall (Fig. 229), and so secures any bleeding points, the forceps being taken off as they are reached. The two free cut edges are secured with a similar "whipping" stitch, after which

the serous surfaces on the opposite side of the opening are approximated and secured by continuous Lembert's sutures, the first threads securing this purpose. It is claimed that this method requires little, if any, longer time than that with plates or rings of any kind, and that it is free from many of their disadvantages, viz., the need of special apparatus, foreign bodies which have to come away, contraction of the opening, which is here so very free, and the collapse of the mucous membrane through the opening.

Dr. Halstead has described another method of intestinal anastomosis by suture only. (*Bulletins Johns Hopkins Hospital*, vol. ii. No. 10). He prefers quilt or square sutures (Figs. 230-233) because one row is sufficient, and they tear out less easily and constrict the tissues less than do the Lembert's sutures. The following are the steps of this method. The two selected portions of intestine having been placed in contact along their mesenteric borders, six square sutures are put in in a straight row, tied, and cut short. At each end of this, the posterior row of sutures and nearer the free border, two lateral square sutures are applied (Fig. 231) tied, and cut short. Eight or nine square sutures are now applied so as to draw together the free borders. These sutures are not however tied, but drawn aside* (Fig. 232), so as to make room for the scissors with which the two segments of intestine are opened. Finally the sutures of the anterior row are tied and cut short.

CLOSURE OF FÆCAL FISTULA OR ARTIFICIAL ANUS.

Fig. 234 shows, diagrammatically, some of the chief points of difference between a fæcal fistula and an artificial anus. Before operating, certain points of much practical importance should be considered, and first how far any spur or septum is developed. The more marked this is, the less is the chance of closing the opening by any slight plastic operation such as paring and suturing the edges of the opening. The spur being left behind, the fæces will make their way through the sutures, and the longer this condition is allowed to remain the more, of necessity, will the lower segment of intestine atrophy, and the more marked will be the difference between the two parts of the bowel. Other important points are the nutrition of the patient and the condition of the area surrounding the wound. The higher the fistula is situated in the small intestine the more will the nutrition have suffered, and the more profuse and liquid is the discharge the wider and the more infiltrated will be the eczematous area around.

Previous Treatment.—We will suppose that the pressure of a truss, the cauter, the use of india-rubber tubing† (Banks), and

* Much in the same way as after an abdominal section in the linea alba, the sutures which have been inserted are drawn aside to draw out the sponge last inserted.

† Mr. Mitchell Banks (*Clin. Notes*, p. 94) describes the following simple and ingenious method. Where the septum or spur is not well developed, it may be

the destruction of the spur* have each been tried in suitable cases.

Operation.—Three will be mentioned. i. *Here the peritonæal sac is not opened.* The margins of the fistula having been sufficiently freed, they are pared and brought together with silk sutures and kept apposed. Hare-lip pins may assist in taking off the tension. This method can only be suitable to small fæcal fistulæ where the exposure of mucous membrane is trifling and no sinus is present. It usually fails from the separation of the edges of the fistula not being free enough, owing to the operator's fear of opening the peritonæal sac, and thus causing tension on the sutures. Mr. Greig Smith (*Abdom. Surg.*, p. 493) recommends the use of reversed and super-imposed flaps. If these should slough, the difficulty of future attempts to close the opening will be increased.

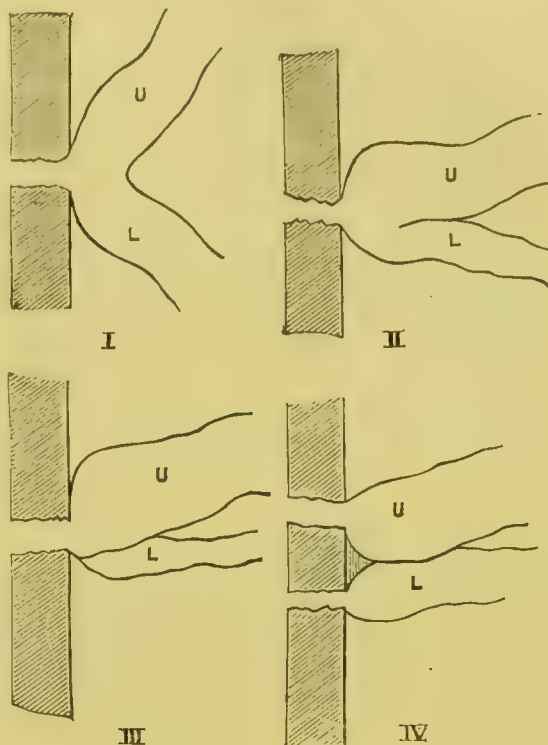
ii. and iii. *Here the peritonæal sac is opened.*
ii. *Closure of the opening without complete resection of the bowel.*

The preliminary steps as to diet and treatment of the eczematous

expected to succeed. In an artificial anus in the groin, after a femoral hernia, he introduced a thick piece of india-rubber tubing, pushing one end up the ascending and the other down the descending bowel. It was secured by silk brought out of the opening. It was calculated that the pressure of the tubing against the projecting spur would pass it back, and allow the fæces to pass round the corner without passing out of the artificial anus. At the end of seven weeks nearly all the fæces passed by the rectum instead of by the artificial anus, this being reduced to a sinus, giving vent to a few drops of yellowish fluid. At the end of three months this completely closed.

* This may be effected by the use of pressure-forceps, as suggested by Mr. Barker. Their use is given at p. 357.

FIG. 234.



U. Upper. L. Lower bowel. I. Fæcal fistula. The gut is not bent very acutely on itself, and there is no spur. The opening in the bowel is usually small and communicates with the skin generally by a sinus-like track. II., III. Artificial anus. The bowel is here more acutely bent and a spur is present. In an artificial anus the opening communicates more directly with the surface than is here shown. IV. Double fæcal fistula. (Greig Smith.)

given below (p. 879) should be carefully attended to. The following account is taken from the report of a patient under my care in Guy's Hospital in Aug. 1895:

At an operation for acute intestinal obstruction due to bands, a gangrenous patch had been found in the ileum and the intestine had been drained through a Paul's glass tube. This the patient pulled out and an artificial anus resulted. The gut was plugged with small sponges tied on silk and pushed about two inches above and below the opening. Two curved incisions were then made so as to include an oval $3\frac{1}{2}$ inches long and $1\frac{1}{2}$ inches wide. In the centre of this lay the opening surrounded by the usual eczematous margin, most of which was enclosed by the above incisions. The incisions passed through the rectus on each side. After the posterior layers of the sheath had been reached the incisions were very cautiously deepened until the peritonæum was reached. In opening this an exploring finger was introduced through each lateral cut so as to make certain that no coils of intestine were adherent beneath. The finger being used as a director the peritonæum was cut through along the lateral incisions in their whole extent. An oval island of the tissues forming the abdominal wall was now set free and could be drawn forward with the bowel adherent to it below, and showing the sponges which had been introduced as plugs bulging out its coats. The bowel in which lay the artificial anus was now separated from adjacent coils and the adhesions which bound it to the parietes, partly with a steel director, partly with blunt-pointed scissors, used at one time closed and at another open. Sponges and iodoform tampons had previously been packed around so as to soak up any blood. When the artificial anus had been separated from all adhesions it was found to be about $2\frac{1}{2}$ inches long. Its edges were pared, and the plugging sponges having been removed the opening was closed with a double silk suture; first a continuous one taking up all the coats and then a row of Lembert's securing sufficient inversion. These were carried well beyond the actual limits of the opening (Fig. 183, p. 827). A little iodoform having been rubbed in along the line of suture the intestine was returned. A few tags of omentum which were adherent to the abdominal wall in the vicinity of the wound were detached and tied. When the intestine was returned the interior of the abdomen was quite free from all blood or other discharges. The edges of the wound were then brought together as far as possible, but this was only feasible above and below. In the centre was a lozenge-shaped gap, measuring $2\frac{1}{2}$ inches long by an inch wide, at the bottom of which lay the sutured intestine. The gap was lightly plugged with iodoform gauze wrung out of carbolic acid lotion (1 in 20). The patient made a good recovery, the only drawback being his weak condition due to his having been fed so long (72 hours, including the time before and after the operation) by enemata. Flatus was passed on the second day, and the bowels acted well two days later. A fortnight after the operation I placed numerous large grafts, cut from the shoulders by Thiersch's method, on the granulating surface which represented the remains of the oval gap in the parietes. All was soundly healed within five weeks of the operation. I lost sight of the patient for five months, when he returned with a ventral hernia. This he attributed to his having had scarlet fever, and to the pad of the belt with which he had been supplied having shrunk after the baking to which it and his clothing had been submitted. He was otherwise in excellent health, without any flatulence or constipation, enjoying his food and able to go about helping his father, who is a costermonger. He was supplied with a new pad. If the hernia increase, it will, I think, be now possible to pare the edges of the old oval gap, and to bring them together, a step quite impossible at the time of the operation.

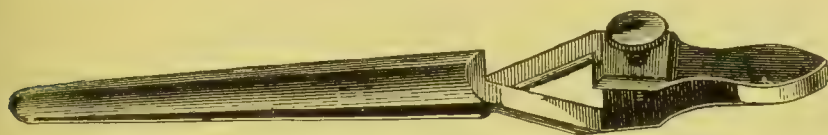
iii. **Closure of the Artificial Anus with complete resection of the bowel.**—If this step be needed I know of no clearer account

than that of Mr. Makins (*St. Thomas's Hosp. Reports*, vol. xiii. p. 18). The skill with which the operation was carried out was only equalled by the thoughtfulness with which it was planned.

The patient was twenty-one. The artificial anus, dating to a hernia, was high up in the small intestine, and opened about $1\frac{1}{2}$ inch above the centre of Poupart's ligament. Here, at the bottom of a small pit, the mucous membrane of the intestine was slightly prolapsed. The gut was firmly attached: the finger only passed into the upper opening; the lower could not be found. First, the usual eczematous condition was very much improved by the use of a small shield, and mopping away of discharge with absorbent wool. No food was given by the mouth after the evening of the second day before the operation, nutrient enemata being given every four hours. During the day before, the upper end of the bowel was washed out with injections of salicylic lotion. As bile-stained fluid was escaping from the fistula an hour before the operation, this washing out was repeated. Before beginning the operation a bit of carbolized sponge attached to string was passed for 2 inches into the upper end of the bowel. A vertical incision of $2\frac{1}{2}$ inches being made through the abdominal wall, the upper end of the intestine, normal in size, was dissected free from its adhesions; the lower end lying just below it was contracted to the size of a pencil, with an opening only large enough to admit a director.*

The two ends of the gut being now provisionally clamped with forceps (Fig. 235), sheathed in tubing, they were drawn out, and a number of sponges

FIG. 235.



Mr. Makins' clamp-forceps, for use in resection of intestine.†

attached to string packed round them. The sponge was then drawn from the upper end of the intestine, and about 1 inch removed from the upper end and $2\frac{1}{2}$ from the lower one, together with a wedge of mesentery 4 inches long by $\frac{3}{4}$ inch wide. The cut surfaces then nearly corresponded. The bleeding points having been tied in the mesentery, this was united with six silk sutures, and the gut then sutured as follows:—A first row of twenty-five very fine Chinese-twist stitches were passed with a small curved needle through the whole thickness of the gut, about $\frac{1}{16}$ inch from its free margin, commencing at the mesenteric border. These were tied in batches of five at a time. Then a second row of Lembert's sutures (Figs. 182 to 184) were passed and tied in the same manner. During the stitching, which took about three-quarters of an hour, the gut was kept moist with warm salicylic lotion. After the bowel was closed and returned, it was found impossible to close the whole wound. As this could only be brought together above and below, the granulations were shaved away and the intestine left at the bottom of a deep pit. Iodoform-gauze and pine-wood dressings were applied. The patient made a good recovery. Two days later the intestine could be seen at the bottom of the wound covered with lymph and

* Over two months had elapsed since the formation of the fistula, and one month since the last proper action of the bowels.

† Mr. Makins prefers these clamps as less cumbrous than any others. If fingers are used, the compression varies a good deal, and dries and damages the intestine. If a temporary ligature of catgut is made use of, and passed through the mesentery, it puckers the bowel and prevents even stitching.

showing vermicular movements. The bowels acted naturally two days after the operation. No faeces came by the wound, but twelve sutures were thus discharged.

ENTEROPLASTY.

This term has been given to an operation for the relief (short of resection) of strictures of the intestine believed to be innocent. It is based upon a similar operation performed several times successfully upon a pylorus, the seat of contraction not due to malignant disease, and called Pyloroplasty (Fig. 245, p. 915). As far as I know Mr. H. W. Allingham's two cases (*Lancet*, vol. i. 1894, p. 1550) are the only ones yet published. One such stricture occurred in a woman aged forty-eight, at the junction of the ileum and jejunum, the other in the sigmoid of a patient aged seventy-three. It is simply stated that "the stricture was innocent," and "not malignant." As the cases were published within two months of the operation, the nature of the stricture must remain very doubtful. The age of the patients, the position of one in the sigmoid, and absence of any history of dysentery, are very suspicious. In each case the stricture was divided in the following way: The bowel having been drawn out, shut off with sponges, and clamps applied above and below, the bowel and stricture were divided longitudinally for three inches, on the side of the gut opposite to the mesenteric attachment. Each lip of the longitudinal incision was then caught hold of at about its centre, pulled apart so that at first it gave the appearance of a diamond-shaped opening, and then by further pulling in the same direction, the original longitudinal incision was made into one transverse to the long axis of the bowel. The opening was then closed, first with a continuous suture uniting the mucous membrane, and then by Lembert's interrupted sutures.

CHAPTER VI.

OPERATIVE INTERFERENCE IN GUNSHOT AND OTHER INJURIES OF THE ABDOMEN. RUPTURE OF THE INTESTINE.

GUNSHOT AND OTHER INJURIES.

WE owe the great advances lately made here, in the first place, to antiseptic surgery, and, in the second, to the zeal with which American* surgeons have taken up the matter and made known their results, unsuccessful as well as successful.

1. *Examination of the Wound, with Regard to Penetration.*—Blackening of the wound and the clothes with powder suggests a close shot and probable penetration. Edges clean cut and equally stained show that the bullet has struck perpendicularly; unequal staining and raggedness suggest obliquity of impact, and the less perpendicular this is, the less the probability of penetration. If there exists a continuous track of tenderness, especially if accompanied with slight redness, from the wound for some distance over the abdominal surface, it is fair to infer that the missile has wormed itself between the layers, without penetration (Parkes).

2. *Symptoms indicating Penetration.*

(a) Circumscribed dullness and bulging near the wound, fluctuation in the peritoneal sac, or either of the last two felt per rectum or vaginam, indicate wound of a large vessel and accumulation of blood, and penetration, with visceral injury, probably; but, to be diagnostic, it must come on within a couple of hours. (β) Rapidly† forming tympanites indicates penetration and escape of gas from the intestine. (γ) Escape of fæces, bile, or urine from the wound is, of course, diagnostic of penetration, but rare. (δ) Repeated hæmatemesis indicates penetration and injury to the stomach or small intestine high up. It may, however, be due to contusion. (ε) Profuse hæmorrhage per anum points to penetration and injury of intestine, but is seldom seen sufficiently early to be of value. (ζ) Hæmaturia indicates injury of some part of the urinary tract. (η) Escape of blood from the wound, if too profuse to be accounted for by a wound of a vessel in the abdominal wall, points to penetration and visceral injury. (θ) Paralysis of any part below the level of the wound is a most grave complication, indicating as it does, injury to cord or nerves, as well as, probably, to viscera. (ι) Shock.

* In addition to the American writers I have quoted below, I have had the advantage of reading a very careful study of this subject by my old dresser, Dr. J. H. Barnard, now of Paris, *Des Plaies de l'Intestin par Armes-à-feu* (Thèse pour le Doctorat en Médecine. Paris. 1887).

† If delayed, the tympanites may be due to paralysis of the intestines from shock.

This does not go for much unless hæmorrhage is clearly present also, owing to the great difference in individual peculiarities.

Other points will be, the size of the bullet and amount of fulminative or powder, the distance and direction in which the firearm was held. A single opening gives *per se*, a faint hope that there is no penetration.

In cases of doubt as to penetration, the wound will be first explored,* the enlarged, and the line of damage to the tissues carefully followed up, any exploring instruments being kept strictly aseptic.

3. *Probable Amount of Damage*.—Dr. Parkes (*Ann. of Surg.*, November 1887, gives the following suggestions:—"An antero-posterior shot below the level of the umbilicus and well towards the lateral surfaces of the body will be very likely to miss the small intestines entirely, and expend its damage on the large bowel. The same kind of wound high in the lateral surfaces may pass into or through the liver without injuring the intestines, or the spleen alone if the entrance is on left side.

"If the wound is so situated that the bullet enters the abdomen through the diaphragm, adding injury of abdominal viscera to that of the contents of the chest, the surgeon's help will probably be of little use. A wound of entrance and exit, or an entrance wound alone, showing passage of the ball from side to side through the abdomen, means the worst of injuries, and suggests the need of the greatest care in staying of hæmorrhage, repair of intestines, and toilet of the contents.

"Antero-posterior perforation, if complete, can only fail to wound the small intestines when situated well on the outskirts of the surface of the abdomen; seemingly there can be no exception to this proposition, save in those extremely rare instances in which the perforating body traverses the cavity without injuring the contents.

"Penetration through the posterior walls of the cavity, if complete, with likelihood of laceration of important fixed organs, argues an injury of the most severe character, one in which the surgeon's aid will be of no avail in the majority of cases. The exceptions in which the severity will not prove insurmountable will be, transit through the space between the lower end of the kidney and the crest of the ilium, and in wounds occupying the outskirts of the entire posterior surface. . . . Many instances are recorded of recovery from posterior penetration of the large and fixed viscera of the abdomen without any surgical operation."

Question of the Advisability of Operative Interference.—While some cases of penetrating wounds with very severe injury (*e.g.*, perforation of intestine and wound of solid viscera) have occasionally recovered, the proportion here is extremely small—Prof. Nancrede gives 8 per cent.; † death from septic peritonitis or hæmorrhage is so common as to justify our urging, in most cases *as early an operation as is possible, after the diagnosis of peritoneal perforation is made*. The exceptions would appear to be, cases where sufficient time has elapsed to allow of much extravasation and the onset of a peritonitis which is certain to be fatal whatever is done, cases of injury to the spinal cord, severe wounds of the solid viscera, and those where such grave collapse, not due to hæmorrhage, is present as to make it certain that the needful interference with the contents of

* Any probe used should not be too fine or sharp pointed. A clean bougie will usually be preferable. The old advice not to probe or explore these injuries must, nowadays, be considered exploded.

† With regard to the mortality after operative interference, Dr. T. S. K. Morton, of Philadelphia ("Abdominal Section for Traumatism"), says that 97 American surgeons operated upon 165 cases, with 62 recoveries and 105 deaths, a mortality of 65.45 per cent.; while 64 foreign surgeons operated on 69 cases, with 34 recoveries and 33 deaths—a mortality of 47.82 per cent.

the abdomen will be necessarily fatal. With regard to the presence of peritonitis Mr. Greig Smith writes (*loc. supra cit.*, p. 704): "Undoubted and severe peritonitis existing on the second and third day is by most authorities recognised as a contra-indication. In such cases it is improbable that the sites of perforation could be found; and, if they were, that they could be dealt with without the production of excessive traumatism. There is little use in cleansing the cavity if it is to be at once refilled, and there is little use in looking for the perforations if they can neither be closed nor fixed in the wound, while there is positive danger in adding to the risk from traumatism. In such cases the most that can be done is to make a small parietal opening with the help of local anæsthesia, and permit the discharge of the noxious fluids, giving the patient the benefit of the remote chance of spontaneous cure with intestinal fistula."*

Prof. Nancrede (*Ann. Surg.*, June 1887, p. 474) thus states the advantages of an operation:—"We can either forestall septic peritonitis or reduce its dangers to a minimum; we can prevent sapræmia—a common cause of death, as I believe. . . . Should peritonitis have set in, we can afford sufficient drainage for the effusions, which may in themselves be already poisonous, or, as we have shown will assuredly become the chief cause of danger; we can substitute for adhesions of doubtful permanency certain methods which secure the escape of the injured portions of gut into the lumen of the bowel; we can prevent the fatal results which must follow the casting off of a decomposing slough of a wounded portion of omentum or mesentery into the general peritoneal cavity; we can arrest hæmorrhage, which from its amount will prove fatal, or from decomposition will equally produce lethal results; we can restore the continuity of the gut, if it be nearly or completely severed, the former condition being not uncommon; we can avoid the risk of fæcal fistula . . . and we can remove a hopelessly damaged kidney or spleen, and repair a wounded pancreas or liver."

Operation.—An excellent account of this will be found in the very helpful article of Prof. Nancrede to which reference has been already made.

With the utmost care the preliminary details of preparation are entered into first—viz., the cleaning and shaving of the skin, the providing of abundance of water recently sterilized by boiling, or a 2 per cent. solution of boracic acid, or a $\frac{1}{4}$ per cent of salicylic acid. Most scrupulous cleansing of instruments. Plenty of soft old linen lying in the hot sterilized water, to cover the intestines with. Abundance of ligatures of gut and silk of different sizes.† In addition to the instruments given at p. 779, two pairs of Makins' clamps should be at hand, or strip of gauze may be passed through the mesenteries and clamped with Spencer Wells' forceps.

"Now as to technique. The patient's limbs and trunk must be carefully wrapped in blankets, with towels, wrung out of the aseptic or antiseptic solution, tucked under and folded over them around the abdomen to prevent any accidental contamination of the peritoneal cavity. If not previously done, the urine should now be drawn off. . . . Ether should be most cautiously administered. The incision should always be median,‡ as otherwise it is almost impossible to gain

* Dr. Barnard (*loc. supra cit.*, p. 58) quotes Dr. Hamilton, of New York, as of opinion that operative interference is contra-indicated if forty-eight hours have elapsed since the accident.

† The temperature of the operating-room should be about 75°.

‡ This point has been much disputed. No hard-and-fast rule should be made, but as a rule the incision should be median. Mr. Greig Smith points out that the following cases require it:—Cases where the ball has crossed the middle line, entering at one side and passing towards the other, and in others where the ball, entering near the middle line, passes either directly backwards or in an uncertain direction. I have alluded to this matter later (pp. 886, 888).

a proper view of the parts, and should usually extend from a short distance above the umbilicus to about 2 inches above the pubes. The abdomen having been opened, any clots or blood which obscure the operating field may be removed but otherwise, unless it is manifest that severe hæmorrhage is going on, the small intestines,* which usually first present, should be carefully gone over, inch by inch, from the stomach to the ileo-cæcal valve, keeping them constantly enveloped in towels wrung out of hot water (sterilized); afterwards the stomach, spleen, liver, pancreas, large bowel, kidneys, bladder, omentum, mesentery,† and abdominal vessels must be examined. I do not mean that, if various wounds are discovered, say in the small intestine, and the place of exit of the ball from the abdominal cavity, all in such relations as would absolutely exclude injury of the stomach,‡ liver, kidneys, spleen, or bladder (p. 1023) such a detailed examina-

* Dr. Barnard (*loc. supra cit.*) points out that wounds of the duodenum are very rarely met with, and that wounds of the upper aspect of the transverse colon and of the omentum at this level are amongst the most difficult to discover.

† "Wounds of the mesentery, when they are but perforations, can be passed without any additional interference, unless attended with hæmorrhage, in which case deligation of the injured vessel is required. Large lacerations should be closed with a running suture to avoid the future possibility of an incarceration and obstruction of a loop of the intestine in the opening. On account of the extreme delicacy of the membrane, its closure is often attended with some difficulty, which may be frequently overcome by introducing the sutures near the edge of a vessel, as this region affords the strongest grasp for the suture" (Shackner, *loc. supra cit.*). If it be the omentum which is wounded, or contain a large hæmatoma, it should be ligatured and cut away.

‡ Cases of wounds of all these viscera have been treated by laparotomy and suture. Thus, Mr. Dalton, of St. Louis (*Ann. of Surg.*, Aug. 1888), records a case of bullet-wound of stomach and liver thus treated successfully. The wounds in the stomach were those of entrance and exit, and situated the former on the anterior surface, the latter near the upper border; both were closed with Lembert's suture. The lower margin of the left lobe of the liver was ploughed through by the bullet $1\frac{1}{4}$ inch from the transverse fissure, leaving a V-shaped wound $\frac{1}{2}$ inch in depth. This was closed by one catgut suture, of large size, passed on either side, an inch from the margin of the wound, and dipping deeply, on account of the great friability of the tissue, into the liver substance. "It acted well, bringing the wound together snugly." There were no other injuries save a slight contusion on the transverse colon, probably due to the spent violence of the ball, which was not found. The operation was rendered difficult by repeated vomiting of black grumous fluid, necessitating turning the patient on his side each time, "which was awkward with an open belly." The operation was a prompt one—two hours after the injury; recovery followed. In Dr. Keen's case (*Med. News*, May 14, 1887) the wound of entrance in the stomach was near the pylorus on the anterior surface, that of exit much more difficult to find, being on the lower border and posterior surface, and obscured by clot. Though there were other most serious injuries of superior mesenteric vein and right kidney requiring nephrectomy, the patient survived till the fifteenth day, death being due to diffuse suppuration of the clot in the mesentery, and gangrenous perforation at one spot in the intestine. Other means of meeting hæmorrhage from the liver are plugging with a tampon of aseptic gauze when the wound is large and the hæmorrhage great, and applying firm pressure, and, in the case of obstinate oozing from an abrasion, the application of a crystal of iron persulphate, or the Paquelin's cautery. Wounds in the gall-bladder are treated like those of intestine. Wounds of the kidney or spleen must be treated, according

ion should be made—far from it, for every unnecessary manipulation is injurious; but I do advise that, rather than overlook a wound, much manipulation which the result proves to have been unnecessary had better be made. Of course the source of a severe hæmorrhage must be at once sought for, and any wounds of the hollow viscera ignored for the time being, care, however, being taken that the general peritoneal cavity is protected from fecal extravasation by removing the intestines outside the abdomen, keeping them wrapped in warm, moist cloths; such hæmorrhage is, however, most unusual. Whichever plan is pursued, let everything be done methodically, and each injury repaired as it is detected, as this saves much time and renders any oversight almost impossible. All wounds of the bowel, however trivial, should be minutely cleansed, coaptated by the Lembert suture of fine silk introduced with an ordinary sewing-needle, and the suture line rubbed over with a little iodoform.* When necessary from the size or number of the wounds, a portion or whole calibre of the gut must be excised.† Wounds of the liver, if situated at the free border of the organ, should, if possible, be coaptated with dry aseptic gut, which will soon swell and fill the track made by the needles. If this cannot be done, the hæmorrhage may perhaps be arrested by the judicious use of the thermo-cautery. Unless the bleeding be free, the wound should be plugged with an iodoform-gauze tampon, which is to remain permanently, or may, perhaps, be carefully removed at the close of the operation, when, if the bleeding be almost entirely checked, the cautery may be used as a further precaution: if the flow be free, the tampon must be replaced and allowed to remain permanently.

“Wounds of the pancreas, spleen, or kidneys must be treated in a similar manner, or, if these measures fail, either spleen or kidney must be excised. Since a wounded splenic artery would lead to gangrene of the organ, it must be removed. The same advice holds good for wound of a renal artery, but in these cases death from hæmorrhage will usually result before art can intervene; still, such possible complications must be provided for. Wounds of the bladder had best be sewn with dry chromic and sulphurous acid gut, which, by its swelling, will fill the track of the little wounds; and the needle should be a round one, as small as can be made to carry the thread. Contused bowel will almost certainly slough, so that the injured portion had better be excised and the healthy peritoneal surfaces united by suture. Wounded or contused omentum or mesentery must also be excised, and the edges carefully united by interrupted sutures. The experience of at least one case has shown that since an omental slough cannot be eliminated into the lumen of the bowel, as occurs in wounds of the intestine, a fatal generalized peritonitis will result from the local gangrene. All bleeding must be checked, even from the smallest vessels, for quite extensive oozing will occur from most insignificant vascular orifices, because they are situated in a closed cavity, and, although the amount lost may not be dangerous *per se*, it will prove so as a source of septicæmia or peritonitis.”

of their nature, either by styptic, cautery, or suture, as in the liver. If the hæmorrhage is too severe for the above, the organ must be removed. Dr. Keen, in his case alluded to above, the kidney being badly lacerated, adopted this step. The ureter should be examined, and, if divided, the kidney should be removed.

* Wherever possible, the sutures should be introduced parallel with the long axis of the intestine, as by this its lumen is least narrowed.

† Of all the wounds of the intestine those of the rectum are most difficult to detect, and therefore very fatal. Dr. Morton (*loc. supra cit.*) suggests that inflation with a rubber bag may be of assistance here. He also alludes to two cases in which the diaphragm was wounded. In each case a hernia of viscera into the thorax existed; this was reduced, the wound sutured with catgut, and recovery ensued.

This was so in Dr. Keen's case (*loc. supra cit.*). The hæmorrhage here extended fan-shaped in a moderately thick layer between the two layers of the mesentery, its periphery extending almost 2 feet along the bowel, and its point being at the mesenteric attachment to the spine. The chief bleeding came from a hole in the superior mesenteric vein, and was secured after much difficulty by a laterally placed ligature of chromic gut. In spite of the most careful antiseptic precautions and unremitting after-treatment, the patient died, on the fifteenth day, of supuration in this clot, and gangrene of the intestine connected with this part of the mesentery. Wounds of the spleen must be treated by the methods already given for the liver and kidney. The treatment of those in the bladder is given fully later (p. 1023).

"If a segment of bowel is to be excised, the cuts should be made at such points as correspond to the distribution of a large mesenteric branch, in order to secure a due blood-supply to the edges of the incisions, and the parts to be removed should be laid upon a large flat sponge, or folded napkins, to prevent faecal extravasation into the abdominal cavity. To avoid escape of *feces* during excision of intestine, the simplest of all clamps is small rubber tubing made to pierce the mesentery on each side of the wound, at a spot devoid of vessels, passed round the intestine, and knotted once, or, better, clamped with Spencer Wells' forceps (Dr. Shackner, *Ann. of Surg.*, June 1890). To obviate kinking* of the bowel, a V-shaped piece of the mesentery must be removed, the branches of the V not corresponding to the cut edges of the bowel, but presenting a free margin of $\frac{1}{2}$ inch, lest want of vascularity cause failure of union at this the most doubtful point. After arresting hæmorrhage, the mesenteric wound must be carefully coaptated by numerous points of interrupted suture.†

"Should the pulse fail at any time during the operation owing to irritation and paresis of the abdominal sympathetic, flushing the intestines and peritonæal cavity with hot water will often at once remove the unfavourable condition. The most scrupulous care must be exercised in the peritonæal toilet, which can be most quickly and effectively made by thorough irrigation of the cavity with warm sterilized water and subsequent careful removal of all fluid in the ordinary manner by sponges, especial attention being paid to the case of the pelvis and the renal regions.

"When possible, the peritonæum should be united over the orifices of entrance and exit of the ball,‡ and a little iodoform rubbed in. . . .

"When incipient peritonitis exists at the time of operation, with the probable formation of large quantities of acrid septicæmia or sapræmia inducing serum, drainage should in all cases be instituted. . . . The tube, preferably of glass, should have its end kept well down between the bladder and rectum in the male, or in Douglas's cul-de-sac in the female, with the external orifice plugged with iodoform cotton."

As many of the above points must be considered, till more cases give us better light, still *sub judice*, I have added, for contrast, the views of another American surgeon, Dr. McGraw, of Detroit (*Trs. Amer. Surg. Assoc.*, May 1889). It will be seen that in some most important points—*e.g.*, the site of the incision and the question of how best to examine the intestines—they are directly opposed to those of Dr. Nancrede. Dr. McGraw's chief propositions are as follows:

* Where the part of the intestine resected is small there is no danger of kinking, and no removal of mesentery is needed.

† Where the security of the suturing of a severe wound of intestine is doubtful. Dr. Senn's plan of giving support by attaching a piece of omentum should be used (p. 867).

‡ If the track of the ball is likely to be septic, it should also be treated by incision, cleansing, and drainage.

i.) Bullets which enter the abdominal cavity pass in a nearly absolutely straight line from the orifice of entrance to that of exit, or their final stopping-place in the viscera. (ii.) An incision made directly in the course of the ball will give the shortest route to the injured parts. If balls pass through the abdomen in straight lines, a cut over the path of a ball will open the nearest possible way to the wound underneath, provided the viscera have not shifted their places since the shooting. Even then they could be easily brought into the wound for the purpose of repair. Coils or viscera which could not be so brought could not possibly have been struck by the ball. (iii.) If a gunshot wound of the intestine will not under pressure permit discharge of its contents, it has been closed by the eversion of the mucous membrane or by the exudation of plastic lymph. In either case the wound would probably recover without suture if kept perfectly aseptic, and if the bowels are kept perfectly quiet. (iv.) An empty condition of the alimentary canal is most favourable for healing. To secure this as far as possible, it may be proper, in some cases of injury of the bowel after a hearty meal, to evacuate the stomach by a syphon. This would be especially indicated in wounds of the stomach, duodenum, and upper part of the jejunum, whether the surgeon does or does not decide on operative treatment. In small wounds of the stomach and duodenum suture may, sometimes, be omitted if the surgeon can be assured that these viscera are empty. (v.) Senn's method of hydrogen-gas insufflation (*supra*, p. 792), however admirable in recent cases, should be used with great caution after the lapse of a few hours. The distension and motion of the gut caused by the insufflation might rupture inflammatory adhesions, break open intestinal wounds that had nearly healed, and make a peritonitis general which had become circumscribed. (vi.) The dangers of the operation are directly in proportion to its length, and to the amount of evisceration. The length of an operation may be lessened—(1) By strictly limiting the examination of the viscera to such of them as may have been in the course of the ball. (2) By suturing wounds in the gut, wherever it is possible, instead of excising them. The latter should be reserved for wounds that do not permit inversion and suture. (3) By omitting all operative procedures, even suture, in all wounds which have become so thoroughly occluded by plastic material that the contents of the bowel cannot be passed through them. (4) When many wounds occur near together, by operating first on those wounds which imperatively demand it, and leaving to the last those which may recover without operation. If the stomach and intestine are both perforated, the small intestine should be first attended to, as the stomach, if empty, may recover without suture. So, too, large wounds should be sutured before small ones, discharging wounds before those which are occluded. (5) By never turning out all the intestines except, first, when hæmorrhage is otherwise uncontrollable: or, second, when there is evidently a discharging wound which cannot otherwise be found. "The examination of the whole intestine by slipping it from one end to the other, through the fingers, though not causing the exposure of evisceration, nevertheless consumes an enormous amount of time, and reduces very materially the strength of the patient. In my opinion, surgeons have exaggerated the difficulties in the way of discovering wounds, which have made this procedure necessary. The incision over the course of the ball will aid materially in the diagnosis by exclusion, for no intestine which cannot be brought into the path of the missile could possibly have been hit by it. It is not probable that a gut would slip more than 3 or 4 inches away from the place it occupied when wounded, and with the incision I have mentioned the necessity would rarely occur of examining any other viscera than those in the immediate neighbourhood of the wound. Let us suppose that a surgeon in operating has repaired all the wounds he has been able to find in or near the course of the ball; he has washed out the abdominal cavity; he has with his hands gently pressed upon all the viscera which could possibly have been injured, and his hands have

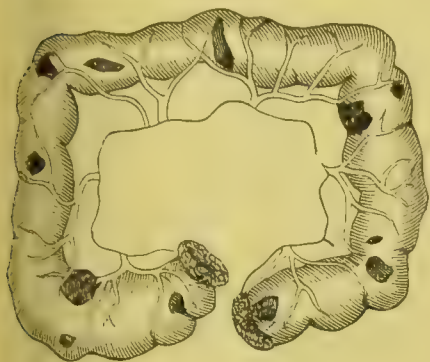
come out unstained; he has, furthermore, with soft sponges, wiped out the lower part of the abdominal cavity without finding blood or feces. Shall he then, without any evidence whatever of an additional wound, subject his already exhausted patient to a most dangerous procedure on the mere suspicion that there might be a still undiscovered wound?"

It will be seen that the diversity of opinion as to the site of the incision, and the desirability of turning out all the intestines for examination, turns on the question of how best all injuries of the peritoneal sac can be detected. The advocates of the latter step and the median free incision claim that by this alone can the needful inspection be made of all the viscera, both free and fixed, hollow and solid; they point to numerous cases in which even by this means of complete examination injuries have been overlooked that have marred the success of an otherwise complete and most hopeful operation; they hold that the median incision alone will meet those cases where the course of the ball is not direct, but erratic or where, by moving the patient a long distance, or from peritonitis setting in late, peristalsis has altered the position of the bowels. Till we have more cases to guide us, I think the published evidence shows clearly that the median incision is the wiser save in a few cases, as where the wounds lie well away from one side, as here the colon may be found shot through, and only this organ and the contiguous small intestine and the kidney behind will require examination. It must not be forgotten that with the great advantage of more complete exploration which the median incision affords goes the greater risk of shock and of general contamination of the peritoneal sac, as coils which are possibly leaking are drawn up into the wound. This will have to be met by careful irrigation later. With regard to turning out all the intestines, the advocates of this step claim that by this alone can all the wounds be found, and that this step, by the more rapid searching which it allows, in reality diminishes shock. Till more cases have been published—and surgeons owe a great debt to the candour and fulness with which the American surgeons have made known their failures as well as their successes—each case must be decided on its merits. The points which will aid the surgeon in coming to a decision on the above two steps are any obliquity of the wound of entrance, and of the course of the ball; the position of the wound of entrance, whether near the middle or the lateral part of the abdomen; any evidence of its having passed from side to side; entire uncertainty as to its course; the time that has elapsed since the injury; the interval between this and the last meal, and whether the patient has been kept quiet.

In cases where the presence of multiple wounds, or the severity of one, entail the risk of sloughing, or where multiple suturing will produce dangerous stenosis, resection must be performed on the lines already fully given at pp. 857, 861. Two very interesting cases are recorded by American surgeons, in which Murphy's button was employed successfully. In one (Dr. G. F. Wilson *Ann. of Surg.*, Sept. 1895), after one wound of the ileum had been found, and closed with Lembert's sutures, eight other openings were found at a considerable distance from the first, three being very close together. Again, some little distance further off, the bullet had passed through the mesenteric border of the intestine, so interrupting the blood-supply that a slough would surely have resulted. A single resection was accordingly determined on, and the portion removed measured, without stretching, just 43 inches. The patient recovered, and the button was passed on the ninth day. In the second case (Dr. J. W. Walker, *Ann. of Surg.*, Jan. 1896), a resection of 2 inches of the ileum was successfully performed. The button was here passed on the fifteenth day. As Dr. Walker remarks, if Murphy's button be used at one place and another wound require suture lower down, any unavoidable constriction which the latter may occasion will cause anxiety as to the safe passage of the button.

The following details are the outcome of experiments by Dr. Parkes.* They have already laid foundations for much good work. "Where several wounds occurred rather close together, and were enough to destroy a considerable portion of the integrity of the bowel, one resection was made to include all of them, even when the length removed measured 10 inches or more. Where the points of injury were widely separated from each other, and extensive damage done at each point, several resections of a length of the tube just sufficient to include the injured portions were made.† In the former case, in which several inches of the tube were taken away, the mesentery was ligated as close as practicable to the intestine (Fig. 215) in sections corresponding to the number of vessels going to the resected portions. The mesentery was then divided close to the intestine, and a V-shaped portion of it removed. After this the tube itself was divided

FIG. 236.



Multiple bullet wounds (ten complete perforations) in eighteen inches of ileum. A good instance of a class of cases most difficult to manage, and fatal in their results. (Parkes.) Resection (pp. 854, 886) would be the wisest course here if the mesenteric vessels were much implicated.

FIG. 237.



To the left a bullet wound is shown pared, with six Lembert's sutures in position ready for tying. To the right the entire circumference of the bowel is shown so mangled as to require resection. (Parkes.)

and the wounded portion removed. One artery always needing ligation was found in the divided ends at the point of junction of the mesentery with the intestine. Before the final division of the intestine, its contents were pushed out of the way, compression being exercised on its walls by forceps or temporary ligature‡ (p. 858, Figs. 212, 215).

"Results soon demonstrated the paramount necessity of carefully selecting the place for final division of the intestine, in order to avoid sloughing of the edges, the results being best in those cases where the division was made close to the point at which any given mesenteric artery approached nearest to the intestine, as compared with those where the cut was made in the intervals between any two branches, and this was seemingly dependent on the better supply of blood. Immediately after division of the intestine, there followed a regular and considerable contraction of the calibre of the tube close up to the divided edge,

* *Gunshot Wounds of the Small Intestines*, Chicago, 1884. Dogs were the patients.

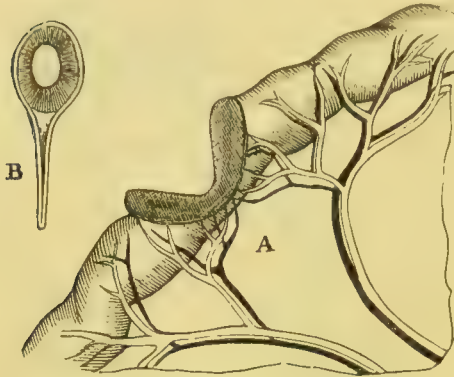
† It seems probable that the greatest success will follow a single resection, even if that include a number of perforations, and involve 8 or 10 inches of the gut, in comparison with those cases where several excisions are made of wounded parts widely separated. See also the cases given at p. 891.

‡ The constriction mark made by the forceps or ligature was to be plainly seen several days after the operation.

caused by the contraction of the circular muscular fibre. This persisted for time, but was soon followed by an eversion of the mucous membrane, which rolled out and over the constricted portion in a remarkable manner (Figs. 238, 238, 239). This protrusion forms a serious obstacle to easy and close approximation of the ends of the bowel; and when turned into the bowel, diminishes its calibre considerably, although it was not demonstrated that the obstruction was ever sufficient to prevent the passage of the intestinal contents. Several attempts were made to get rid of it, but all these were finally abandoned.*

"In all instances where a perforation was severe enough to require a resection of the wounded part, it was found advantageous to leave, if possible, a strip of the bowel near the mesenteric junction (Fig. 238), taking out the wounded portion by a V-shaped incision. The part left acted as a support to the wound

FIG. 238.



A shows the strip of bowel left at the mesenteric border; B, the triangular interval where the mesentery encloses the gut, a spot very hard to close. (Parkes.)

FIG. 239.



(Parkes.)

avoided division of the blood-vessels, opposed the action of the longitudinal fibres, and in no instance in which this plan was adopted was there any appearance of separation of the wound.† . . . Perforations through the mesenteric surface of the intestine were the most difficult to treat, and, even if slight, seemed always to require a complete excision. A partial excision of this surface of the bowel resulted in an acute-angled elbow which never did well. The point of attachment of the mesentery with the bowel will usually be found the most troublesome to manage in applying the sutures in restoring a complete division . . . The difficulty arises apparently from the manner in which the folds of peritonæum separate from each other before passing on to invest the bowel, leaving a little triangular interval filled with loose connective tissue, fat, and

* Thus "it was pared away with scissors; it was dissected up from the other coats for $\frac{1}{4}$ inch from the edges; but the conclusion was finally reached that instead of being a harm, its presence was useful in giving support, protection and, perhaps, vascularity to the freshly sutured edges; at least, in all instances where it was removed the stitches were found torn out and union defeated; in no instance where it was left entire did there fail to be union in some part, and no sutures gave way when properly applied."

† Dr. Parkes found that, in small perforations of the stomach and intestine the case did well after drawing the peritoneal surfaces some distance from the edges thereof over it by a continued suture, thus converting it into a linear wound. He thinks this plan may safely take the place of excision in not a few cases of quite severe injury.

vessels. Now, if the suture fails to include the muscular coat as well as the peritonæum at this point, the junction will surely give way. To make this point secure, the greatest care must be taken in placing at least three sutures, this number being usually quite enough to include the troublesome area, and these should always be the first sutures applied. In completing the junction, it assists materially, and especially avoids trouble from the everted mucous membrane, to apply one at the most convex surface, and then one half-way down on each lateral surface. . . . The greatest number of mishaps followed drawing the sutures too tightly, which, if done, leads to death of the applied edges and of course to failure. They must be drawn only sufficiently close to bring the surfaces fairly in contact; the subsequent swelling from obstructed circulation will hold the surfaces firmly together until glued to each other by the rapidly forming adhesive material."* With regard to the best way of disposing of the divided mesentery after removal of some length of intestine, Dr. Parkes does not seem to be decided. It would seem from his account, which is not clear on this point, that after tying the mesenteric vessels (Fig. 239) and suturing the divided ends of the intestine, the cut mesentery should be united to the now joined intestine, making as nearly as possible a continuous surface of mesentery.

The chief points in the after-treatment are rectal feeding for forty-eight hours or longer if the stomach or upper part of the intestine have been injured.† Periodic emptying of the drainage-tube with a syringe, or even irrigation through it. Morphine injections, combined with atropine (about $\frac{1}{10}$ gr.) for the first thirty-six or forty-eight hours rather than opium. Cold to the abdomen by means of an ice coil. Careful use of saline aperients, *e.g.*, Seidlitz powders, a little later.

I append the following as instances of what injuries the surgeon may expect to have to deal with. Bullet wound near umbilicus; seven openings in alimentary canal—viz., three openings close together in the small intestine ($3\frac{1}{4}$ feet below the duodenum), two openings in the descending colon, and two in the rectum; no great extravasation; also a large vein wound in the mesentery; death from peritonitis; bullet found near ischial spine (Annandale, *Lancet*, April 15, 1885); Pistol wound near navel; seventeen hours later, operation: 2 pints of bloody serum let out, with small clots, but no fæces; seven penetrating wounds of intestine, six in the small, one in the sigmoid containing the bullet; all the openings plugged with ragged, everted mucous membrane; no fæcal escape till edges were separated; careful suturing and toilet; recovery after a very critical condition for a week (Bull, *Ann. of Surg.*, May 1885). Bullet entrance close to navel; operation two hours later; abdominal cavity full of blood; a spiriting artery in the mesentery; eleven wounds requiring suture in small intestine, and two in ascending colon; no fæcal extravasation, but a melon-seed body found and removed; on the thirteenth day great rectal tenesmus led to discovery of blood effusion in pelvis; 3 pints let out by incision about 2 inches within anus; recovery, bullet passed per anum (Hamilton, *Journ. Amer. Med. Assoc.*, August 22, 1885; *Ann. of Surg.*, November, 1885). Bullet entrance $3\frac{1}{2}$ inches above umbilicus, and just to left of middle line; operation within twenty-four hours; rent in omentum close to great curvature of stomach, and two linear rents in this viscus found with much difficulty; operation had to be concluded quickly from patient's critical condition; death within a few hours from acute peritonitis; four wounds

* The sutures were of No. 1 catgut or No. 2 silk; fully curved round needles are recommended, or, preferably, ordinary straight sewing-needles. The method used was the continuous or Lembert's (Figs. 184, 185). Great stress is laid on not allowing the needle to enter the cavity of the intestine, lest the sutures and their track become septic.

† The passage of a long tube may bring about the escape of flatus, and so give great relief.

found in upper part of jejunum, all within a distance of 3 inches (Briddon, New York Surg. Soc., December 8, 1886; *Ann. of Surg.*, April 1887). Bullet wound two inches above and two inches inside right anterior superior spine; operation in nine hours; wound found in ascending colon pouring out fæces; another wound in colon also pouring out fæces; both sutured; recovery (McGraw, *Chicago Med Journ. and Exam.*, July 1887; *Ann. of Surg.*, December 1887).

A very complete table, containing 234 cases, is given by Dr. T. S. K. Morton (*Journ. Amer. Med. Assoc.*, Jan. 4, 1890); others by Sir W. MacCormac and Mr Barker will be found in the *Brit. Med. Journ.*, May 11, 1887, and March 17, 1888.

More recent papers will be found in the *Annals of Surgery*. One of the most interesting is by Dr. A. B. Miles (vol. ii. 1893, p. 623). Thirteen cases are given with five recoveries. In proof of the severity of these cases, of the recoveries one patient had sixteen, another fourteen, and a third ten wounds of the small intestine. One of the fatal cases was due to the discharge of both barrels of an ordinary shot gun into the right iliac fossa.

RUPTURE OF THE INTESTINE.

The following remarks are taken from the Cartwright Prize Essay by Dr. B. F. Curtis of New York (*Amer. Journ. Med. Sci.*, Oct. 1887): *Relative frequency of rupture*, in 113 cases.—Duodenum, 6; jejunum, 44; ileum, 38; "other parts of small intestine," 21; large intestine, 4. While the duodenum and large intestine escape from their sheltered position, the jejunum is most frequently ruptured in its first three feet, the ileum in its last three. Fæcal extravasation is almost invariably present. The most frequent and important complication of ruptured intestine is laceration or contusion of the mesentery; this is important from the rapidly fatal hæmorrhage, or later, gangrene. The cases of ruptured intestine fall clinically into three classes. (A) The shock never leaves the patient, may never lessen, but pass, rapidly or slowly, into fatal collapse. This may be due to (1) the shock of the accident; (2) to hæmorrhage; (3) to fæcal extravasation. (B) Those in which evident peritonitis develops. The diagnosis is easiest in these cases, but unfortunately they are not the most common. (C) The most common. Instead of evident peritonitis setting in after reaction has taken place vague symptoms appear, keeping the surgeon in expectation of it, but giving nothing on which he can found a positive diagnosis, for the same slight indications are common in cases in which ultimate recovery has taken place. Patient is apathetic, seemingly satisfied with his condition, and thus misleading; or, getting gradually weaker, and therefore, being less able to complain, appears to be improving. Peritonitis in this group of cases develops so slowly that its beginning cannot be noted. *Duration of life*.—The average taken from 113 cases is forty-eight hours. *Chief points in the diagnosis of rupture of intestine*.—Cause—*e.g.*, a kick. This was so in 28 per cent. of the cases. The intestine is crushed between the spine and the force employed. The severer the injury—*e.g.*, a kick by a horse—the more likely is the intestine to have been injured. Rigidity of the abdominal wall, and pain and tenderness at one spot are the most reliable symptoms. Tympanites, a later sign,* is of grave omen, as it greatly embarrasses operative interference. Shock† and vomiting afford less valuable evidence, unless persistent. The absence of each has led to fatal delays. A certain diagnosis is

* When present early and abolishing the liver dulness this is almost pathognomonic of injury to the alimentary canal.

† Shock is quite unreliable, as it depends, not only on the severity of the injury but on the idiosyncrasy of the patient.

seldom possible for twelve hours or longer, but the surgeon should not wait on this account. The risk nowadays of doing harm by exploring in cases where no laceration of the intestine or mesentery is present is much less than that of waiting to explore until the onset of a septic peritonitis affords certain evidence. As in intestinal obstruction, abdominal section is the only means of clearing up the diagnosis.

Mr. Robson (*Clin. Soc. Trans.*, vol. xxi. p. 130), advises as follows on the question of operation: "In cases of doubt one is so prone to wait, hoping for the turn of events, and then to arrange to operate when too late, that it is well to have some formulated rule, and for my own guidance I have adopted the following. In cases where there is a reasonable belief that the intestine is wounded exploration by a small median incision must be made, when, if there is any rupture of the bowel, flatus, or serum tinged with blood, or feculent material will escape through the small peritoneal opening which can be enlarged and necessary treatment adopted; but should no flatus or fluid appear and the peritonæum prove to be healthy, the small wound can be closed."

That the best chance is afforded by early operation as soon as the period of shock has passed off, is proved by recorded results (Battle). This surgeon points out (*loc. infra cit.*) that in the second paper read before the Clinical Society (*Trans.* 1890) by Mr. Croft, out of fourteen cases then collected only one was completely successful, a case operated on by Mr. Croft, and between 1890 and 1894 Mr. Battle had collected fifteen cases, seven of which recovered.

Treatment.—Where rupture of intestine or severe hæmorrhage is probably present, exploration should take place as soon as the period of shock has passed away, but in the severest contusions there are many chances that the intestine has escaped. The incision should be median and a long one, at least four inches, the parietes here being normal, not distended and atrophied as in abdominal tumours. When all the intestine has to be drawn out and examined—and no operation can be otherwise complete—the incision should be eight inches long. In any case the centre should be at the umbilicus, unless it is clear that it is the stomach that is injured. It should not be lower down, or the attachment of the mesentery may interfere with the pulling out of the intestine, especially if it be short and thickened with fat. Blood may show through the peritoneum before this is opened. When this membrane is incised a sponge should be passed in on clamp-forceps to search for blood, fæces, or pus. If hæmorrhage is going on, the opening the abdomen may stop it (Parkes, *Med. News*, May 17, 1884), or it may increase, causing grave symptoms. If blood well up, a hand should be passed in, under the omentum, upwards and backwards, to make pressure on the abdominal aorta and root of the mesentery. All the small intestine is then turned out into hot aseptic towels, bleeding points are then found and secured with clamp-forceps while the pressure is relaxed to note the effect on the bleeding. The bleeding having been arrested, any injury to the intestine is sought for. If a rupture is found, the part should be kept outside in a hot aseptic towel, while the rest is returned. If hæmorrhage is slight or absent the intestine should be draw out loop by loop, and inspected till the whole is examined. Fæcal extravasation should be avoided by extremely careful handling of the intestine, the wound thus remaining unsoiled. When all the intestine is inspected, the peritoneal sac should be carefully cleansed as at p. 816. Any distended coil may be aspirated and the puncture tied up or opened as at pp. 782, 815. If the large intestine be much distended, a long rectal tube may be passed and manipulated along through the walls of the intestine. Small ruptures will often admit of suture without resection. Other viscera may be injured and have to be dealt with (*vide supra*, p. 884). When the case is too grave to admit of resection being performed and of the necessary plastic repair taking place, the best course is to make an artificial anus by closing the ends of the intestine with ligatures or clamps, then to thoroughly cleanse the

peritonæal sac, next bring the ends out and insert Paul's tube (pp. 824, 856); or pass the parietal deep sutures farther back than usual, so as to thoroughly evert the peritonæum, and trust to the presence of these sutures, together with finer ones and plenty of iodoform, to hold the ends of the emptied intestine in place until the adhesions are firm. This course ought not to take more than half an hour. Where the injury is high up in the intestine additional risk must be run in order to avoid, by resection, the artificial anus which is so harmful here. If the anus be made use of, it should be closed as early as possible, or the nutrition will suffer fatally (p. 876). Saline infusion may be resorted to with great advantage, early in the operation, before the period of collapse, perhaps irrecoverable has set in. No operation should be performed if marked collapse is present. If the patient does not respond to stimuli, he will not survive laparotomy.

The following are some of the conditions which have been met with in exploration of injury to the intestine. In Dr. Wiggins' case, to which I have already alluded, 36 hours after the boy had been kicked by a horse, the abdomen was opened and the small intestine withdrawn and carefully examined, beginning with the ileo-cæcal region. Near the jejunum a bruised and livid knuckle was discovered. Though no perforation was made out in it prior to the resection, a small perforation was found afterwards near the mesenteric border. About 6 inches were resected, the ends being united by Maunsell's method. Owing to the patient's "coming-to" and straining while the resection was being performed blood and faecal matter escaped into the peritonæal sac, this accident being due to the safety-pins used as clamps being too large. A 50 per cent. solution of hydrogen-dioxide was poured in and allowed to remain while the ends were being united, and the cavity was afterwards flushed with, and finally left full of, sterilised salt solution. The patient, a boy aged fifteen, made a good recovery (*New York Med. Journ.*, Jan. 20, 1894). In a case fully reported by Mr. Battle (*Lancet*, vol. i. 1894, p. 1121, a paper which will well repay perusal), the following was the condition present when the peritonæum was opened.* A gush of blood followed and as the patient was straining, a coil of intestine was forced out, a rent was found in the mesentery of this coil, bleeding freely. While this hæmorrhage was being arrested with clamp-forceps, the open end of a piece of intestine sprang into the wound. The other end was found by tracing the mesentery along. This portion of mesentery was much contused and lacerated, and there was a second complete rupture about 8 inches from the first. Only a small portion of the contents had escaped, among which were one or two partly digested beans. As it was evident that the condition of the mesentery would result in gangrene if it were left, resection was performed, nearly 13 inches being removed with a large wedge-shaped piece of mesentery. While a lateral anastomosis was being performed here by Senn's method, it was discovered that a third rupture existed about a foot beyond the second. This rupture was not quite complete. It was closed "by means of Senn's plates, cut to the required size, and a ring of Lembert's sutures used to further strengthen the union."† The patient did well until the fifth day, when evidence of perforative peritonitis set in. The abdomen was again opened, and it was found that the end-to-end union had broken down, leading to leakage. An artificial anus was made, but the patient never rallied.

Mr. Croft has recorded two cases of rupture of the small intestine without external wound (*Clin. Soc. Trans.*, vol. xxi. p. 254, and vol. xxiii. p. 141).—These must be looked upon as pioneering cases, as far as this country goes, in the modern

* The patient, aged twenty-four, had been kicked in the abdomen by a horse. He was admitted into St. Thomas's Hospital shortly after, and was operated upon about six hours later, when the shock had passed off.

† This operation lasted over two hours, and owing to the increased shock, five pints of saline solution were injected with a good effect.

treatment of these injuries. Both patients recovered, the one completely, after primary enterorrhaphy by Lembert's method; in the other case an artificial anus was made. This was closed by resection of the intestines, four weeks later, but the patient sank thirteen hours after the operation from exhaustion, due chiefly to "the irrepressible escape of intestinal contents at the artificial anus." The following points amongst many others are noteworthy in the two last instructive cases. In the first case three separate lesions were discovered; the ileum had been ruptured transversely for two-thirds of its circumference at the junction of its upper and middle thirds. There was a laceration of $1\frac{1}{2}$ inch in the mesentery in the same neighbourhood, and a considerable rent in the omentum above the level of the umbilicus. Fæcal peritonitis had spread from the ruptured intestine into the iliac, umbilical, and hypogastric regions, $18\frac{1}{2}$ hours having elapsed between the injury and the operation. The peritonæum was very carefully irrigated with warm boracic acid solution from 16 to 20 per cent., and the edges of the ruptured intestine brought out into the wound. Mr. Croft points out that the result of this case shows that it would probably have been a safe practice to have trimmed the edges of the ruptured gut and completed an enterorrhaphy by Lembert's sutures, as the irrigation was evidently efficient. This would have saved the inanition and debility consequent on the establishment of an artificial anus, the external irritation and the septic condition of the parts around the opening, and the second long and risky operation required to close it. In the second case, fourteen hours had elapsed between the operation and the kick from a horse. A faint fæcal odour was observed when the peritonæal sac was opened, and about $1\frac{1}{2}$ ounce of fæcal fluid were found extravasated between some coils of intestine adherent to each other and the omentum. On tearing through the adhesions and separating the coils on the right side, about 2 inches below the umbilicus, a small rupture was found in the ileum, situated in an areola of inflamed and ecchymosed tissue. Resection of the damaged intestine was performed, the ends being united by about 40 Lembert's sutures. The peritonæal sac was carefully purified with a hot 20 per cent. solution of boracic acid. The patient, aged fourteen, made an uninterrupted recovery. I can only find space for one other of these most interesting cases. It is recorded by Mr. W. T. Thomas, Assistant-Surgeon to the Royal Infirmary at Liverpool (*Brit. Med. Journ.*, vol. i. 1894, p. 1355). It presents the following points of interest. (1) The slightness of the injury. The patient, aged fifty-five, had, twenty-four hours before the operation, struck her abdomen against a chair which she was carrying before her, and which caught against a doorpost. (2) The absence of symptoms in a case of severe septic peritonitis, only distension and tenderness being present. When the abdomen was opened, about half a pint of putrid serum, with large yellowish flakes of puriform lymph, escaped. The intestines were all distended, and as no collapsed coils could be found, the small intestine was withdrawn. After 2 feet had been examined, a perforation was found* about $\frac{3}{4}$ inch long, from which oozed fæcal fluid. This was closed by two rows of continuous Lembert's sutures, the mucous membrane being carefully tucked in. Thorough irrigation with a 1 per cent. solution of carbolic acid was then carried out, a glass tube being left in. The patient made a good recovery.

* The site of the rupture was not given. Nor is it stated whether much difficulty was met with in dealing with the distended intestines.

CHAPTER VII.

OPERATIONS ON THE STOMACH.

GASTROSTOMY. — GASTROTOMY. — DIGITAL DILATATION OF PYLORUS. — PYLOROPLASTY. — EXCISION OF PYLORUS. — GASTRO-JEJUNOSTOMY. — DUODENOSTOMY AND JEJUNOSTOMY.

GASTROSTOMY.

Indications.

1. Certain cases of cancerous stricture. This also includes invasion of the œsophagus, secondarily, from primary cancer of the mediastinal glands, &c. 2. Cancerous disease of the pharynx; and, in a few cases, malignant disease of the tonsil or back of the tongue not admitting of operation.

A very interesting case is given by Mr. Whitehead (*Brit. Med. Journ.*, July 22, 1882). Here, in a patient aged forty, excision of the tongue had to be followed by tracheotomy and gastrostomy, owing to the original extent of the disease. At the last report the patient was alive, four months after the gastrostomy, five after the removal of the tongue. Two such cases are given by Mr. Stonham (*Lancet*, Oct. 2, 1886). One patient survived four months; the other, one. In this case the growth was so extensive as to necessitate tracheotomy at an early stage of the gastrostomy. Both patients experienced great relief. Tracheotomy was also required in Mr. King Green's case (*Lancet*, Feb. 3, 1883), though here the disease was either in the pharynx or upper part of the œsophagus. I think that in such cases, also, the last few months of life might often be rendered much more comfortable by a timely performed gastrostomy.

3. Cicatricial stricture, whether traumatic or syphilitic.

The first of these, from its frequency, requires separate notice.

1. Cancerous Stricture.—Here several points call for attention. Amongst the chief are—the question of the treatment of œsophageal cancer by passage of tubes or gastrostomy; the mortality of the latter operation; and the best date for performing it.

Between treatment by gastrostomy and that by tubes no fair comparison can be made, because the former operation has, in such a large number of cases, been performed under most unfavourable conditions. Much too often it has been put off till the patient, scarcely able to swallow liquids, is just kept alive by enemata. Such patients, worn out by the miseries of slow starvation, often with secondary disease and lung and pleural trouble, are not in a condition to be submitted to abdominal section, and

are not likely to respond to the call made upon their vitality to unite two serous surfaces firmly together, on which depends the success of the operation.* I do not think that I exaggerate if I say that, in a distinct proportion of the cases in which the surgeon is asked to perform gastrostomy, the hand of death is already on the patient, and something next door to the decomposition of the grave has already set in, owing to the extension of the disease.

In advising gastrostomy, each case must be decided on its merits; the patients here are not only adults, but well on in life, and, when assured that the end is certain, the surgeon may, in most cases, having put all the risks before the patient, leave it to him to decide. But I think that if the patient, having previously declined it, only asks for operation when it is clearly too late, the surgeon should be firm enough to decline to operate in cases where, on every ground, his interference will be hopeless.

The following points help in a decision between gastrostomy and tubage: i. Food taken.—As long as pulpy, semi-solid, or a proportion of solid food is taken, tubage may, if preferred, be persevered with. But when the time comes that the patient is becoming restricted to liquids, the hour for a successful gastrostomy is slipping by. When the patient is fed by enemata only, and merely takes ice by the mouth, it is too late to operate. ii. Amount of pain felt with and difficulty in passing bougies or tubes.—Any sensation of a rough, raw surface, any blood or broken-down tissue on the bougie, increased expectoration, dyspnœa, paroxysmal cough (this may occur after even a teaspoonful of fluids), fœtor of sputum or bougie, make it evident that the passage of instruments causes advance of ulceration and sloughing; when this is increasingly accompanied with pain and evidence of laryngeal irritation, gastrostomy should be proposed. iii. Site of stricture.—The lower down this is, the more difficulty will there usually be in dealing with it by dilatation, and the nearer are important parts. iv. Condition of patient.—Here the rate of emaciation must be watched—anything like loss of 1 to 2 lbs. a week is very ominous. How far is the strength preserved? how far does the patient tend to give up his life-habits? how far is he bed-ridden? Where the pulse is thready, the extremities cold, the temperature never up to normal, the case has gone too far. v. Condition of viscera.—Evidence of implication of trachea or bronchi, of pleuritic effusion, and of broncho-pneumonia must be sought for. If there is reason to believe that the growth has extended beyond the œsophagus, operation should usually be declined. vi. Rank of life.—A patient who can afford all the luxuries of life, and who can have everything done to palliate his condition, is, obviously, in a very different condition to one in a humbler position.

* Such statistics as those of M. Blum (*Arch. Gén. de Méd.*, Nov. 1882) require revision now.

I would thus sum up this question of gastrostomy or tubage :— As long as a patient can swallow sufficient solids or semi-solids treatment by tubes and bougies may be persevered with. When ever they can be introduced, the tubes ingeniously devised by Mr. Symonds* will be preferred. These have a funnel-shaped extremity resting on the upper end of the stricture, are introduced by a conical bougie, and are kept *in situ* by a loop of silk which is looped round the ear. They are not unsightly, have the great advantage of allowing the patient to swallow his saliva and food, and thus retain the pleasures of taste. If the silk break great trouble may accompany the removal of the tubes.

If a larger pattern of bougie is needed, none is more suitable than the flattened bulbous one, ending in a conical point, of Mr. Durham.†

Any surgeon treating cancerous stricture here by dilatation must remember that treatment of cancer in this way is contrary to what is generally practised, and is only justifiable here on special grounds—*e.g.*, the fatality of the disease and the risks of gastrostomy; that these risks have been enormously increased by the way in which this operation has been deferred; that there comes a time in these cases when tubes can no longer be made use of; and that if gastrostomy has been deferred till now it had better not be performed at all. In other words, the patient should understand that if he shuns the risks of an early operation, he renders himself liable to other but as serious risks by deferring it till an hour when he can only ask for it, and the surgeon only attempt it as an almost utterly forlorn hope.

The question of which gives the greatest comfort cannot be answered dogmatically. But no one who has seen many cases of gastrostomy, and met with a fair proportion of success, will hesitate to prefer the result of this, if performed early, with its gain of weight and freedom from pain and irritation during the few months which in any case remain, to the passage of tubes necessarily more and more frequent and difficult as the case progresses, with the not infrequent distress and choking when they are introduced, the blockage of the hollow ones by sputum or food, and the needful withdrawal and re-introduction, easily

* *Clin. Soc. Trans.*, vols. xviii. p. 155, xxii. p. 306; *Brit. Med. Journ.*, April 23 1887. See also Dr. Rodman's two cases, *Brit. Med. Journ.*, May 25, 1889. It is clear from these cases that patients can be kept alive as long and gain weight equally by tubage as by gastrostomy, and that in some cases even a malignant stricture can be dilated. On the other hand, the passage of tubes, where there is considerable narrowing, clearly requires some force, and thus needs skilled and very careful hands. Even in such hands, fatal mischief has been inflicted. Furthermore, the blocking of the smaller tubes which alone will pass in the later stages through tight and ulcerating strictures, will necessitate frequent changing irritation, and thus hastened sloughing of the growth. The close contiguity of this to the trachea, pleuræ, &c., must not be forgotten.

† *Syst. of Surg.*, vol. i. p. 798. The bougies are made by Kröhne and Hawksley.

effected, no doubt, for some time, but ever irritating and fretting the growth.

I have performed gastrostomy twelve times, in each case for cancer of the œsophagus: in six patients the operation was asked for too late; in one, my seventh case, the patient died from an accident, for which I am responsible (foot-note, p. 902); the other five recovered well. One, a young married woman, had had symptoms six months; she was in the fourth month of pregnancy when operated on: she lived in comfort for six months, and died, a month after giving birth to a child at the full time, of extension to the lung. Another patient lived between three and four months, and would have survived longer if it had not been for his carelessness as to exposure. A third was alive and progressing satisfactorily when last heard of four months after the operation. The fourth is still alive, four months after his operation. The fifth made a good recovery, but I lost sight of the case nine weeks after the operation.

Operation (Fig. 240).—Method of Howse* by Two Stages.

First Stage.—Those precautions being taken against shock, such as warm wraps, hot-water bed, table, or bottles, ether as an anæsthetic if the condition of the lungs admits of it, and if it is quietly taken without troublesome, heaving breathing, the surgeon will usually find it most convenient to stand on the right side and to have his patient drawn over to this side of the table. The shoulders should be somewhat raised and the hips slightly flexed, to relax as much as possible the tension of the soft parts, which often fall with embarrassing sharpness over the epigastric angle from the prominent ribs down to the wasted, retracted umbilical region (Fig. 240).

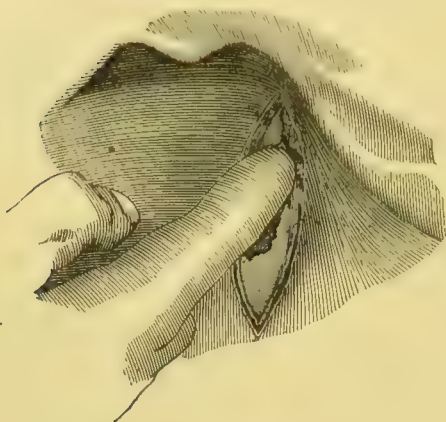
Mr. Howse (*Dict. Pract. Surg.*, p. 590) recommends the following incision: (1) An oblique one, about $2\frac{1}{2}$ inches long, parallel with and about 1 inch below the lower margin of the left costal cartilages. This incision should start about $1\frac{1}{2}$ inch from the middle line, and its length must depend on the varying development of the rectus muscle. It should not go higher than the above point, as it will not leave enough free skin and muscle between the cartilages and the incision to fasten the sutures to. This first incision is only to be carried through the skin and fascia. When made, the sheath of the rectus will be seen at the inner end, and at its outer end a portion of the linea semilunaris and of the external oblique. The usual plan of continuing the operation is to have the muscles and fasciæ of the abdomen incised in the same way as the superficial parts. Mr. Howse prefers to continue the operation as follows: (2) The lips of the wound being separated

* Mr. Greig Smith (*Abdom. Surg.*, p. 302) states that the plan of operating in two stages was originally suggested by Egebert, a Norwegian surgeon (1841), and also advised by Nélaton. It is to Mr. Howse's practice, however, that we owe our knowledge that this operation is safe if performed in two stages, with strict antiseptic precautions, and when not too long deferred.

towards the inner part as widely as possible by retractors, a vertical incision is made in the sheath of the rectus a little distance from its outer margin. The vertical fibres of this muscle will then be seen, and these should be separated, not cut, with a steel director, and the posterior part of the sheath exposed. This may then be incised vertically.

From my experience of twelve cases I prefer, as simpler, a single vertical incision (Fig. 240) beginning opposite to the end of the eighth intercostal space and passing down for 3 inches over the

FIG. 240.



The finger searching for the stomach through a vertical incision.

rectus—*i.e.*, about 2 inches from the linea alba. The fibres of the rectus, being exposed, are torn straight through with a steel director, and the posterior, somewhat concave layer of its sheath exposed. This is carefully divided for the full length of the incision, and the extra-peritonæal fat (if present) and the peritonæum picked up and opened together. A finger is now introduced (Fig. 240) to feel for the stomach.* All irrigation should be stopped before the peritonæum is opened, and every care taken that everything brought in contact with the wound is strictly aseptic.

As a rule, the contracted stomach lies high up under the left lobe of the liver, and requires to be hooked downwards and forwards into the wound. Not unfrequently the great omentum presents first, and it is easy, by seeking too low down, to draw up the colon. In case of difficulty the best plan is to find the anterior border of the liver, trace up the under surface to the portal fissure, and thence along the lesser omentum to the stomach. This is told by its thicker, more substantial feel, and pink-red colour.

The stomach being drawn up, a part is chosen on its anterior surface, free from vessels, and as near as possible to the cardiac end.

The stomach is next fixed to the edges of the wound with sutures of carbolized silk and salmon-gut. Mr. Howse thus ties his chief sutures over bits of bougie: "Drawing the stomach well over to one side, a needle (in handle) carrying the silk should be passed through the serous and muscular coats of the stomach only, and should then transfix the abdominal parietes about 1 inch from the wound. The needle is now withdrawn, leaving one end of the silk on the surface, and, without unthreading the other end, the

* While the finger feels for the stomach, it also examines for any enlarged glands.

abdominal parietes are again punctured alone. The needle is now threaded and withdrawn. The two ends of silk will thus be left projecting from two distinct wounds on the skin, close by one another, and holding up a bit of the serous and muscular coats of the stomach. Before tying any one suture it is best to introduce the others, drawing the stomach well over from the side towards which it is wished to introduce the suture. Six or eight sutures introduced in this fashion are usually used. The result is to fix the gastric peritonæum in a circle about 1 inch round the wound. The part of the stomach exposed in the wound should then be fixed to the lips of the incision by small wire sutures, introduced by a small curved needle held in a needle-holder, these again only taking up the serous and muscular coats of the stomach."

In my cases I have dispensed with the above, using many (five or six on each side, and one or two at each angle) sutures of fine sterilized silk in the ordinary way, but passed with strict attention to the directions given below. By some, hare-lip pins* have been used. I advise in any case, to ensure apposition of the peritoneal surfaces, that the parietal peritonæum be first sutured to the edges of the wound. In some cases Mr. Howse has dispensed with sutures, keeping the stomach *in situ* with torsion-forceps protected with drainage-tube. Save in very urgent cases, I think careful suturing is much to be preferred.

The additional time spent in careful stitching will well repay the operator. However the sutures are inserted, the following points, in which Mr. Howse in introducing his operation laid much stress, should be carefully attended to: (α) To make the needle travel for a sufficient distance in the muscular coat in taking up the stomach. (β) Not to include or puncture the mucous coat, for fear of causing septic fistulæ. (γ) To bring the needle through the parietes quite an inch from the edges of the wound. (δ) In doing so, to include the parietal peritonæum. (ε) To bring up a circle of stomach a full inch in diameter.

When the stomach is secured—and the sooner it is to be opened, the more carefully must the stitching be carried out—a sugges-

* *Lancet*, February 20, 1886; *Brit. Med. Journ.*, December 6, 1884. The pins, if used, must be very fine ones, or gastric fistulæ, or gangrene and abscesses as in Choeborn's case, may result. Mr. Chavasse, in the first of the above papers, figures "a running or gather-stitch." This is simple in its application and effectual, but it would seem likely so to close the wound as to render the second stage difficult. This method and pins have the advantage of rapidity. Mr. Sessett (*Surg. Dis. of Stomach and Intestines*, p. 56) fixes the stomach thus. The convexities of four chromic gut loops are passed into the muscular coats of the stomach at the four angles of a parallelogram; each free end, threaded on a needle, is thrust through the abdominal wall about $\frac{1}{4}$ inch from the edges of the wound, and then through a decalcified Senn's plate, over which they are tied. A portion of the stomach is next drawn through the opening in the plate, and fixed by a hare-lip pin.

tion, I believe, of Mr. Bryant's should be followed, and a fine suture of silk or catgut introduced in the centre to guide the surgeon, in a few days, to a safe site of puncture (*vide infra*). The upper and lower angles of the wound are next closed with sterilized salmon-gut.

Free as the wound has seemed before, it is now markedly puckered up. A little iodoform is dusted on, some protective and iodoform gauze wrung out of carbolic acid lotion, 1 in 20, applied, and then dry sal-alembroth gauze dressings and wool, with a many-tailed bandage.

When in bed the position of the patient must be such as to relax the parts. A little morphine should be given subcutaneously, whenever not contra-indicated; great attention paid to keeping the patient warm, and nutrient enemata, followed by one of Burroughs & Wellcome's nutrient suppositories, given every three, four, or six hours.*

Second Stage.—This, in all cases admitting of delay, should be deferred till the third, fourth, or fifth † day, so as to give time for firm adhesions to form between the two surfaces, and thus to soundly shut off the general peritonæal sac. No previous change of dressing will probably have been required. The wound is now found still more puckered, its edges inverted somewhat, and almost in apposition save for the strips of gauze which have been inserted. The stomach surface is no longer recognizable as such, being coated with lymph, this showing the importance of a guiding-suture. Close to this the stomach wall is punctured by a quick stab with a very sharp tenotomy knife, the wall being raised and steadied by the loop. A piece of No. 7 gum-elastic catheter is then slipped in as the knife is withdrawn.‡ A bit of tubing and a small tunnel having been attached to the end of the catheter, a little milk and brandy is thus quickly given. The tube is then tied with silk or plugged, and left projecting amongst some strips of dry gauze which cover the wound. Collo-

* Thirst may be relieved by glycerine and iced water as a mouth and throat wash, and occasional enemata of warm water.

† Mr. Howse has usually adopted this date. In one case (Sir W. MacCormac, *Brit. Med. Journ.*, August 2, 1884) the performance of the second stage was deferred for seven weeks, some power of swallowing having returned. A guiding stitch had been left in.

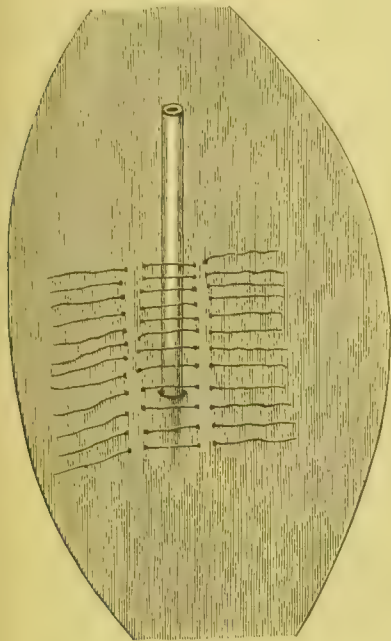
‡ This sounds simple enough, but it is by no means always easy to feel certain that the stomach has been opened. This is due to the puckered contraction of the wound and alteration of its surface, the stomach coat being thus no longer recognisable, and to its lying much deeper than would be expected, making "the operator sometimes fear that he has punctured the lesser bag of the peritonæum" (Howse). In one case, my seventh, though I thought I had punctured the stomach directly and sufficiently, it was not so. The patient dying two days after, peritonitis and fluid food in the abdominal cavity were found. The puncture and catheter had both run obliquely through the stomach wall, and communicated with the cavity of this viscus and the sac of the peritonæum as well.

lion and iodoform are an excellent application after the fourth or fifth day. Larger catheters are soon introduced, and then india-rubber tubes large enough to admit of finely minced solids in a pulptaceous form.

The above given method of gastrostomy, though improved by keeping the part of the stomach to be opened up between the fibres of the rectus, so as to ensure a certain amount of sphincter action is liable to be followed—though this is by no means constant—by leakage of the gastric juice, especially when the patient coughs, and eczematous irritation in consequence. To meet this, the following modifications have been brought forward.

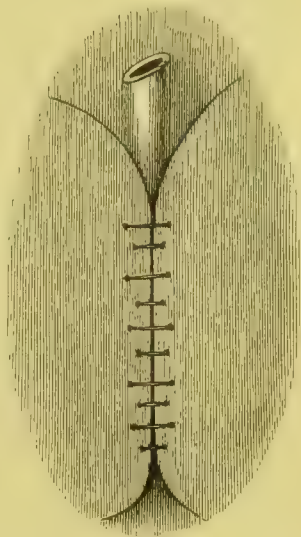
ii. Witzel's * Method (Figs. 241 and 242).—The peritonæum is

FIG. 241.



Witzel's method of gastrostomy. Lembert's sutures have been so placed in the walls of the stomach as, when tightened, to draw two folds of the walls of the stomach over the tube. (Meyer.)

FIG. 242.



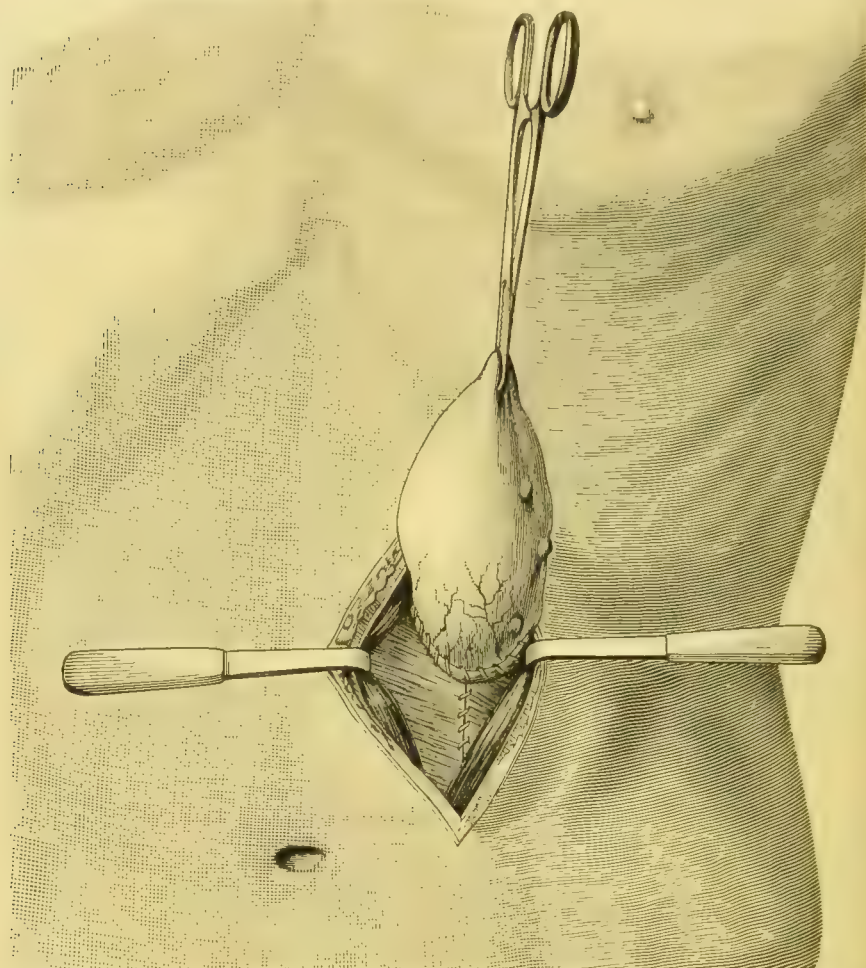
Witzel's method of gastrostomy. Sutures tied and the tube embedded in the walls of the stomach. (Meyer.)

opened either by the insertion of the finger parallel to the left border of the ribs, or, as I prefer (p. 900), by one through the rectus muscle. The stomach having been drawn out a very small opening is made near its cardiac end and a snugly fitting rubber tube introduced and then buried in the wall of the stomach for about two inches by Lembert's sutures, two folds of the stomach wall being

* *Centr. f. Chir.*, 1891, p. 601. An interesting account of this method from which Figs. 241 and 242 are taken, is given by Dr. W. Meyer (*Ann. of Surg.*, vol. i. 1893, p. 592). Witzel gives two successful cases. Dr. Meyer quotes Mickulitz as having operated five times successfully, and as recommending Witzel's method as the best.

stitched over the tube, as seen in Figs. 241 and 242. The free end of the tube is then brought out of the wound, while the area around it is stitched carefully to the peritonæum on either side of the wound in the parietes. Prof. Keen (*Ann. of Surg.*, vol. ii, 1893, p. 639) thus managed this part of the operation. The tube having been sutured into the stomach, three sutures were inserted

FIG. 243.



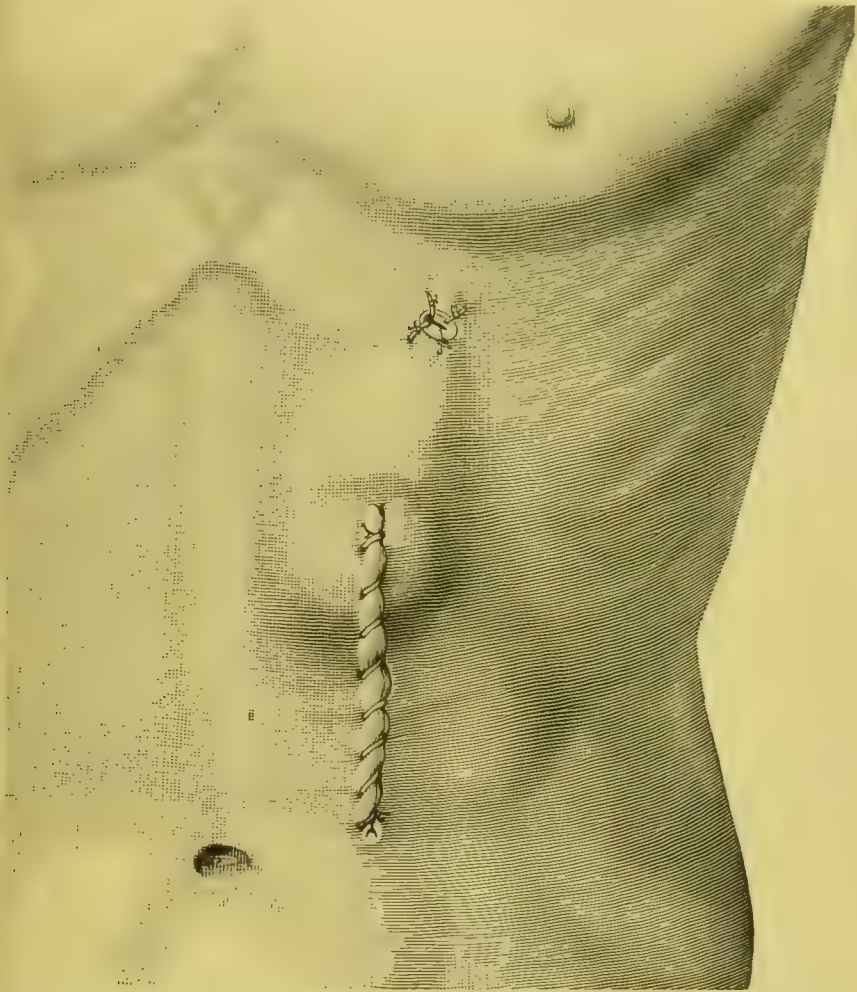
Albert's method of gastrostomy. The stomach is drawn upwards, while below the peritonæum and deeper layer of the sheath of the rectus have been stitched to it by a continuous suture. Retractors hold the fibres of the rectus apart. (Kocher.)

into the walls of this viscus, but not tied before it was returned within the abdomen, the needles being left threaded. As soon as the stomach was replaced these needles were thrust through the abdominal wall, and the stomach brought up to the margins of the opening. The edges of the wound having been sutured, the upper end of the tube may be closed with a clip, and the usual dressings are applied. Feeding by the stomach is begun at once. Any leakage is prevented not only by this oblique entrance of the tube into the stomach, but as shown by a specimen obtained from a patient of

Dr. Meyer (*loc. supra cit.*) by the fact that Witzel's ingenious method of stitching the stomach walls over the tube causes a short artificial cone to protrude obliquely into the lumen of the stomach.*

iii. Method of Albert (Figs. 243 and 244).—The peritonæum is opened either by an incision parallel with the costal cartilages, or

FIG. 244.



Gastrostomy by Albert's method, completed. Below is seen the chief wound closed by a continuous suture. Above is the small opening through which the stomach has been opened. (Kocher.)

by one just within the linea semilunaris high up. The stomach having been drawn out a long conical diverticulum of the anterior wall of the viscus is pulled well out of the wound and the parietal peritonæum and the posterior layer of the sheath of the rectus are sutured round its base, care being taken not to constrict it too

* Another advantage of Witzel's method is illustrated by one of his cases. In a patient who had been operated upon for cicatricial stricture of the œsophagus, the fistula closed spontaneously within sixteen days after the stricture had been dilated and the tube removed from the stomach (Meyer).

much (Fig. 243). A continuous suture is used and every care taken not to perforate the mucous coat of the stomach. A small incision is now made through the skin a little above the front and on the level of the costal cartilages. The skin between the two openings having been separated from the subjacent parts, the diverticulum of the stomach is drawn up under the skin and over the costal cartilages as far as the small skin incision, to the edges of which its apex is united by a few sutures. A small opening is next made here into the stomach, and the orifice fixed to the skin by one or two points of suture (Fig. 244). The lower part of the wound is then closed by a continuous suture. As a result the diverticulum of the stomach is drawn upwards, its base is gripped by the muscular fibres of the rectus, while a short upward-directed subcutaneous œsophagus is also formed. All escape of fluid is thus prevented and the patient can be safely fed at once.

iv. Hahn's* Method.—Here the stomach is drawn out by an incision just below the costal margin, and a second incision having been made in the eighth intercostal space, the stomach is drawn out here and fastened between the cartilages. The disadvantages of this method appear to be decided; and in addition to the risk of opening the chest, necrosis of the cartilages has followed in the hands of Von Hacher and Hadra. In patients so reduced as those who usually present themselves for gastrostomy any additional risks are most distinctly to be avoided. Finally, the sphincter or stop-cock action of the ribs can be far more simply attained by the methods of Witzel or Albert, especially that of the former.

For the first few days milk and brandy, just warmed, and peptonized if preferred, should be the chief food, given with the yolks of one or two eggs. A little later beef-tea, soups, well-pulped vegetables, with plenty of fluid, should be given. In Mr. Howse's words, "When the larger sizes of tubes have been introduced, solid food may be poured into the stomach by the aid of a large wide-mouthed syringe. This food should be minced meat, with a certain proportion of vegetables, all finely ground in the mincing machine."

Patients are often very ingenious in feeding themselves. Some, to enjoy the taste of food, have masticated solids and then passed them through the fistula.†

If the operation has been deferred till too late, and it is absolutely needful to feed the patient at once, the best method will probably be Witzel's. If the older operation be performed, a small amount of liquid may be introduced every few hours through one of the large hypodermic syringes made for explora-

* *Wien. Med. Woch.*, 1886, Band xxxvi. s. 1073-1110. *Wien. Klin. Woch.*, 1890, s. 693.

† Thus, Mr. Durham (*Syst. of Surg.*, vol. i. p. 803; *Lond. Med. Rec.*, March 1878) mentions a patient of Trendelenburg's who, after masticating his food, spat it into a funnel, and then forced it on through a tube into his stomach. Two of my later patients have fed themselves after this fashion through a tube.

tion, and holding a drachm or two. The puncture must be repeated at each occasion of feeding; obviously a risky proceeding.

Dilatations of Strictures of the Œsophagus from below through an opening in the Stomach.—Where non-malignant strictures low down in the œsophagus resist dilatation from above, and the patient is losing ground, the stricture may be attacked from below in one of the following ways.

(i.) **By Gastrotomy**, the opening being closed at the same time. Prof. Loreta, of Bologna, operated on the first case in 1885.* The patient, aged twenty-four, had swallowed caustic alkali. Attempts to dilate the stricture by bougies were unsuccessful, and at last it became impossible to pass any instrument. The point at which the sound was arrested seemed to correspond with the fourth dorsal vertebra. The patient was entirely unable to swallow, and emaciation had become extreme. Eleven months after the injury an incision about 5 inches long was made from the xiphoid cartilage downwards and to the left. Some difficulty was met with in finding the stomach, owing to its contraction and the way in which the liver overlapped it; but at length the operator succeeded in drawing the greater part of the stomach out of the wound, and a longitudinal incision was made through its walls between the two curvatures, having its upper end as near the cardia as possible. The next step was to find the orifice of the œsophagus, in order to introduce the dilator; but this involved considerable difficulty,† and the search was interrupted by a considerable quantity of bile, which regurgitated from the duodenum into the stomach. At length, by searching with the left index between the under surface of the liver and the small curvature of the stomach, the end of the œsophagus was found. Then the distended stomach was kept drawn down by an assistant while the operator introduced a dilator (something like that of Dupuytren for lithotomy). The wound was then sewn up and the stomach returned. The patient rallied well, and in six hours swallowed some soup, with the yolk of an egg, to his great joy, as for twelve months he had been unable to do more than swallow mouthfuls. Recovery is stated to have been complete.

Mr. Kendal Franks has related an instructive case of the same kind (*Ann. of Surg.*, vol. i. 1894, p. 385). Here the whole of the right hand was introduced into the abdomen, and the index finger into the stomach through an opening an inch long situated about midway between the curvatures and the orifices. As the finger could only just reach but not dilate the stricture, an Otis's dilating urethrotome (the blade having been removed) was guided by the finger into the stricture, screwed up, and withdrawn fully expanded. After this had been done both laterally and antero-posteriorly, an œsophagus bougie could be easily passed through the stricture from above. The wound in the stomach was united with two continuous sutures, one uniting the mucous membrane, the other, by Lembert's method, the peritoneal coat. The patient made a good recovery. Large-sized bougies could be passed without difficulty or pain.

It is clear that the above method may be resorted to with great benefit in non-malignant strictures, low down in the œsophagus where the dilated condition above the contraction makes it very difficult to hit this off with a bougie. (ii) **By Gastrotomy.**—This, while rendering manipulations safer in a measure, cripples the surgeon's movements, as it will be impossible, however much the fistula be dilated, to get the finger passed through it anywhere near the stricture in the œsophagus.

* An excellent summary of Prof. Loreta's cases is given by Mr. Holmes (*Brit. Med. Journ.*, Feb. 21, 1885).

† See the directions given at p. 911.

Instrumental dilatation can alone be made use of through a gastric fistula, and for this reason the method by two stages is inferior to the other. It has been most ingeniously used under the following circumstances. In 1889, Hagenbach (*Correspondenzblatt Schweizer Aerzte*, No. 5) directed a patient with a non-malignant stricture of the œsophagus to swallow a small shot attached to a long thread. This was drawn out of the stomach through the fistula and a strong silk thread fastened to it and drawn up through the mouth. To the lower end a bougie was tied and increasing sizes were daily drawn through the fistula.

Dr. R. Abbe of Newport (*Ann. of Surg.*, vol. i. 1893, p. 489) advises what he calls the "string" method in the treatment of dense fibrous strictures. A gastrostomy having been previously performed,* a small gum-elastic bougie is guided through the stricture from below up into the mouth, and a stout silk ligature passed in the same way. This silk being see-sawed backwards and forwards the stricture is felt to yield, and larger bougies can then be passed.

Difficulties in and after Gastrostomy.

i. The very prominent angle formed between the ribs and the sunken umbilical region (p. 899). ii. Hæmorrhage. This will be almost *nil* if the rectus fibres are separated with a director, and the veins on the stomach carefully avoided. iii. Finding the stomach. iv. Drawing this up into the wound if itself affected by disease, as when the primary disease is situated very low down in the œsophagus, or if it is adherent by reason of secondary deposits. v. Jerking breathing due to the anæsthetic. vi. Completing the second stage of the operation. vii. Intense pain on introducing food into the stomach.

In a patient of Mr. Butlin's (*Brit. Med. Journ.*, April 14, 1883) this was found to be the case, the patient dying nearly a month after the operation. Mr. Butlin attributes this pain to his opening having been close to the pylorus.†

If it is thought that the opening is made too near either extremity of the stomach, it would be well after feeding to keep the patient turned on to the opposite side. viii. Leakage of gastric juice and regurgitation of food. This is an extremely troublesome complication, leading, as it does, to most rebellious eczema and erysipelas. Witzel's or Albert's modifications will prevent this.

If the older operation be employed, as small a wound as possible should be made in the abdominal walls, going through the rectus muscle, and opening the stomach by a mere puncture. If, in spite of these precautions, leakage still takes place, leaving out the tube for a few hours at a time will allow of some recon-

* In this and the preceding instance the gastrostomy opening should be placed as high up as possible. In his case Dr. Abbé opened the œsophagus near the root of the neck as well as performing a gastrostomy.

† Thus causing constant dragging on a fixed part. The middle or cardiac end of the stomach should be opened, as being more movable and less likely to lead to rapid escape of the food. In a case of Mr. McCarthy's (*Lancet*, 1887, vol. ii. p. 859), for the first few days severe pain was felt, after each feeding, in the left shoulder. This gradually disappeared.

traction. The patient should also be kept as flat as possible after feeding. Regurgitation of food is often due to the stomach being opened too near to the pylorus.

In some cases of gastrostomy for non-malignant stricture the fistula has been subsequently closed. I did this in 1877, at Mr. Howse's request, in a most successful case of gastrostomy of his for œsophageal stenosis after swallowing a corrosive poison. Mr. Davies-Colley has published another equally favourable ending in a case in which the œsophageal mischief had been syphilitic (*Guy's Hosp. Reports*, 1884, vol. xxvii. p. 367).

Causes of Death after Gastrostomy.

1. Inanition and exhaustion, the operation being performed too late. 2. Peritonitis. 3. Extension of the disease to surrounding parts—*e.g.*, trachea, bronchi, &c. 4. Lung affections—*e.g.*, pneumonia due in part to the operation—*viz.*, the anæsthetic and enforced recumbency. It is especially frequent in "too late" cases. 5. Hæmorrhage—*e.g.*, from ulceration into aorta or lung. 6. Acute gastritis. 7. Suppuration between stomach and liver, and due probably to irritation round one of the sutures.

GASTROTOMY.*

Indications.—These are very few, the majority of bodies swallowed passing through the pylorus. Of the few which will call for operations, forks, as in MM. Labbé's and Péan's cases, and masses of hair, as in Mr. K. Thornton's (*Lancet*, January 9, 1886) patient, are good instances. Increasing pain, vomiting, emaciation, and sufficient time having elapsed to allow of the body passing, will be the chief justifications of an operation. In a very few cases (pp. 907, 910) gastrostomy will be required to aid the removal of foreign bodies impacted low down in the œsophagus.

Operation.—A. FOR REMOVAL OF BODIES FROM THE STOMACH.—Such cases as Mr. Thornton's show that this operation can be safely performed at one stage.

The parts being cleansed and the abdomen relaxed, one of the following incisions is made:—(1) Over the body itself, when this can be felt. (2) In the case of a large body, in the middle line, from the xiphoid cartilage down to or below the umbilicus. (3) One of the incisions given for gastrostomy—*e.g.*, one parallel with the left costal margin and about an inch below it, reaching from a point near the xiphoid cartilage obliquely downwards and outwards to a point opposite to the ninth rib. One of the first two will probably be the best. The abdominal wall having been divided, and the peritonæum opened, the exact site of the foreign body is made out.† If this be pointed, great care must

* By this term is meant an incision into the stomach for the removal of foreign bodies, the opening being immediately afterwards closed, as opposed to "gastrostomy," the making of a more or less permanent fistulous opening.

† It has been proposed by some to facilitate finding the stomach by distending this with effervescing media; but as Mr. Greig Smith points out, the disadvantages are serious—*viz.*, trouble to the patient, liability of the distending medium to escape into the peritonæal sac, and, lastly, the increased difficulty of finding the body in a distended stomach. In Mr. Thornton's case, the hair, weighing 2 lb., greatly distended the stomach. It would probably be well, in the case of a smaller body, to wash out the stomach beforehand with a dilute solution of boracic or salicylic acid.

be taken not to let it damage the stomach during the needful manipulations. In such cases the external opening must be free, that the surgeon may see what he is about. In the case of such a body as a fork the blunt end must first be found.

When the surgeon has decided where to open the stomach, he brings this part out of the wound and packs sponges all around it, so as to steady it, and also to shut off the peritonæal sac.

The stomach is now opened with scissors by an incision transverse to its long axis, and of length adapted to the case. As far as possible any vessels must be avoided, but any that spring will at once be commanded by Spencer Wells' forceps. The body is next extracted with suitable forceps or a scoop, care being now taken not to damage the stomach, especially if the foreign body has set up inflammation or ulceration, and to allow no blood or mucus to escape into the peritonæal sac.*

Before introducing the sutures, Mr. Thornton placed a carbolized sponge "to keep the edges in apposition for suture and to prevent accumulation of blood in the organ. Fifteen sutures of fine carbolized silk were then introduced through all the coats, the needle being slanted through the wall so as to come out just at the inner edge of the mucous membrane, which was much inclined to curl. The interrupted sutures were passed so as to control the cut vessels, and no ligatures were used. Another row of similar sutures was then passed between each of the deep sutures, but only through the peritonæum. The deep sutures entered the peritonæal coat about $\frac{1}{4}$ inch from the edge of the incision, and were $\frac{1}{3}$ inch apart; the superficial sutures were entered about the same distance from the edge, and ran along just under the peritonæum. When these were all in place the sponge was removed from the stomach, and they were tied, the deep first. These two rows caused some inversion of the peritonæum, and the two outer and upper edges of the peritonæal edges of the depression thus formed were brought together by a continuous suture of very fine carbolised silk. . . . The closed wound measured exactly 3 inches."

Stomach feeding was only commenced forty-eight hours after the operation, a teaspoonful of iced water and milk being given every half-hour, the quantity being increased till the afternoon of the next day, when 2 oz. were given every hour. On the sixth day 3 oz. were given every two hours. On the fourteenth day corn-flour was added to the diet, on the fifteenth some crumbled bread, and gradually an ordinary light diet. During the first week 3 oz. of beef-tea were injected into the bowel every three hours, with 20 drops of laudanum every six hours. The patient made an excellent recovery, though Mr. Thornton had to remove a sponge from the abdomen the day after the operation.

B. FOR REMOVAL OF BODIES—e.g., TOOTH-PLATES—IMPACTED IN THE LOWER PART OF THE ŒSOPHAGUS.—These cases, though rare, are so difficult as to call for some remarks here. Prof. Richardson, of Harvard University, first brought forward a very successful case of this operation (*Lancet*, 1887, vol. ii. p. 707). A plate carrying four teeth had been impacted eleven months in a patient aged thirty-seven. Numerous attempts had been made to remove it from the mouth. The plate was successfully removed by gastrotomy, by an incision 6 inches long, parallel to the lower margin of the left ribs. The following interesting details are given :—

Determination of the Site of the Foreign Body.—In an individual of average height, and with a neck of ordinary length, the distance from the incisors to the

* Mr. Greig Smith (*loc. supra cit.*) writes: "When the foreign body has been removed, it may be wise, if there is much mucoid, purulent, or bloody material in the stomach, to cleanse it by means of small sponges on holders. The less the stomach is irritated the better, however."

diaphragm is $14\frac{1}{2}$ inches. All parts of the œsophagus are accessible to the finger either by gastrotomy or external œsophagotomy. With the right forefinger introduced by œsophagotomy and the left by gastrotomy, it was found possible, not only to make the fingers touch, but in many cases overlap. But these results are only approximate, as it would not always be possible to do both operations on a patient. It is possible to reach with the left hand 3 inches above the cardiac opening—*i.e.*, the length of the left middle finger. From above, through the wound in the neck, one cannot reach quite so far on account of the sternum and clavicle. Allowing in the average neck $1\frac{1}{2}$ to 2 inches from the cricoid cartilage to the lowest point of the wound in the œsophagus, we have the average distance from that incision to the cardiac opening of $5\frac{1}{2}$ or 6 inches. If the obstruction be less than 6 inches from the cricoid, an attempt should be made to remove it from above; if more than this, or 13 inches from the teeth, gastrotomy should be performed. The incision that, on the whole, is recommended is an oblique one below the margin of the left ribs. The stomach being drawn up into the wound, it is most essential to put the lesser curvature on the stretch, so that it makes a straight line to the diaphragmatic opening. The cut through the stomach wall must be far enough to the right to allow the passage of instruments along the sulcus between the anterior and posterior walls of the stomach, made tense as above. If the instrument is brought obliquely to this groove and passed upwards, all the time being pressed gently against the straightened lesser curvature, it will glide into the œsophagus every time with the greatest ease. The opening in the stomach should be first large enough to admit instruments; if these fail, it must be enlarged, and the whole hand introduced.

In the following case I was much less fortunate, owing to the way in which the tooth-plate was jammed above the cardiac orifice. While such cases are rare, they are most important, on account of the numerous difficulties which they present.

E. W., aged forty-four, was sent to me at Guy's in May 1889, having swallowed a vulcanite tooth-plate, which "stuck in his throat." The plate originally carried seven, but now only two teeth. A medical man whom he saw at once pushed the plate down with a bougie. An emetic which had been given then acted and brought up some blood. The patient complained of constant pain in the epigastric region, just below the xiphoid cartilage, and in his dorsal vertebræ. Swallowing was painful, and so was eructation of gas, though this gave relief. Patient was able to swallow food quite well. He was not troubled by vomiting. A bougie could be passed into the stomach, but just before it entered it rubbed over a foreign body. The body did not yield in the least to any force which I thought it justifiable to use with the bougie. June 11th I operated as follows: The stomach having been washed out with dilute boracic acid, an incision $3\frac{1}{2}$ inches long was made, parallel with the linea alba, commencing on the level of the xiphoid, and about an inch to the left of it. The rectus, the sheath being opened, was split with a steel director. The stomach was very small and pale. Sponges having been packed around, it was opened, with scissors, just to the right of the cardiac end, and as high up as possible. The opening was about $\frac{1}{4}$ inch long. Three small vessels sprang, and were tied. The exploring finger detected the body imbedded just above the cardiac orifice. The mucous membrane around felt pulpy and swollen. Numerous curved forceps were introduced by the opening, and then along the lesser curvature, but, though the body was repeatedly seized, I was quite unable even to loosen it. This was due to its not presenting any projecting points and to the swelling of the mucous membrane around. I next enlarged the opening in the stomach so as to introduce my hand, but, though with the tip of the middle finger I was able to reach the plate, I was unable to dislodge it. Mr. Durham and Mr. Davies-Colley

also tried, with a like result. Moreover, to steady it, Mr. Tubby was good enough to keep the end of an œsophageal bougie pressed against it from above. I closed the lower two-thirds of the wound in the stomach with Lembert's sutures of fine silk, and stitched the remaining part to the upper part of the parietal incision, so that other forceps might be tried later on. The patient, however, never rallied completely, and sank about forty-eight hours afterwards. At the post-mortem examination the coronary arteries were found in an advanced stage of atheroma. There was no peritonitis or escape of gastric contents. The mucous membrane near the cardiac orifice of the stomach presented a ragged appearance, dating to the prolonged manipulations. The plate was very firmly fixed in the œsophagus, $1\frac{1}{2}$ inch above the cardiac opening.

DIGITAL DILATATION OF THE ORIFICES OF THE STOMACH.

We owe this operation to Prof. Loreta,* of Bologna, whose two first cases Mr. Holmes was, I believe, the first to bring prominently under the notice of English surgeons.

DILATATION OF THE PYLORUS.†

Operation.—The stomach should be well washed out‡ a few days before, and also on the morning of the operation, with dilute solutions of boracic or salicylic acids,§ and the time fixed should be as early as possible in the day. The previous meals should be fluids, small in amount and readily digested. The skin being cleansed, an anæsthetic given, and the parts relaxed, an incision about 5 inches long is made either in the linea alba or on the right side of the middle line, from a point about 1 inch below and outside the xiphoid cartilage to one just below the cartilage of the ninth rib. Hæmorrhage is arrested before the peritonæum is opened, and one or two fingers introduced to feel for and examine the pylorus. No definite tumour will probably be felt, but distinct hardness of the pylorus. If the omentum is adherent to the stomach, it must be separated after both this and the pylorus are drawn out of the wound. Sponges are now most carefully packed around the pylorus, and the stomach is opened, with blunt scissors, about the centre of its anterior aspect, but rather nearer to its pyloric end.|| Any bleeding points are secured by Spencer Wells' forceps; then the right index examines the condition of the pyloric orifice. While attempts are

* Prof. Loreta's first case is reported in the *Lancet*, August 18, 1883. The ninth operation, one of dilatation of the cardiac orifice, is briefly given in the same journal, April 26, 1884. Mr. Holmes' summary, a very full one, of two papers by Prof. Loreta, will be found in the *Brit. Med. Journ.*, February 21, 1885. Any surgeon about to perform these operations should refer to this. Mr. Haggard's case—the first successful one performed by an English surgeon—was published in the *Brit. Med. Journ.*, February 19, 1887. In the same journal for March 17, 1888, is a note that the patient continues perfectly well.

† For reasons given below (p. 914), this operation will be largely replaced by pyloroplasty. Dilatation of strictures low down in the œsophagus from the stomach is given at p. 907.

‡ This may also bring about some contraction of the viscus.

§ In one case, that of Mr. Pearce Gould's (p. 914), the use of this only was followed by temporary ill effects. As long as the washing out is thoroughly done, boiled water used tepid will be quite efficient.

|| Of course, any large vessels will, as far as possible, be avoided.

made to dilate it, this end of the stomach is steadied by the left hand. Much gentleness and patience must be used in applying the great force which is often required for dilatation. Mr. Haggard, finding that he could not introduce his finger, used a pair of dressing-forceps, and, having thus started the dilatation, followed it up by the passage of a female urethra dilator (probably having guarded the blades with drainage-tube), and dilated gradually till he was able to get his "index and next finger into the duodenum without feeling them at all tightly packed." Prof. Loreta, in his first case, having introduced his right index, found that "no force that could be safely used succeeded in dilating it till the left index was also introduced and employed to steady the pylorus. When this was done, the end of the right forefinger was gradually squeezed through the aperture. Then the finger was used to hook down the pylorus towards the abdominal wound, a manœuvre which enabled the operator to get the left index also through the pylorus. But it was still exceedingly difficult to effect any separation of one finger from the other, so great was the resistance, not only of the sphincter itself, but also of the coats of the stomach and duodenum. The attempt at dilatation threw the muscular fibres into spasmodic action, which quite overcame all the force that could be exerted. Three such attempts were made in vain, but then the pylorus began slowly to yield to the force employed, which was very considerable. At length a sensation was experienced, 'showing that the tissue was so far distended that it could not obey the dilating finger further without being torn.' The fingers were now kept apart for a short time, and the spectators noted that one finger was about 8 centimetres (more than 3 inches) from the other." *

The wound in the stomach is next closed with Lembert's suture, of carbolized silk; or the method employed by Mr. Thornton, p. 910, may be made use of. The sutures should pass through any points that still bleed after forcipressure is stopped. If any ligatures are really required, fine chromic gut should be used. Perhaps the introduction of a sponge during the insertion of the sutures may facilitate this step by everting the mucous membrane. When the stomach is soundly closed, the sponges are removed from the peritonæal sac,† the viscus replaced, and the wound in the abdomen carefully closed. It should be noted that in Mr. Haggard's case "terrific bleeding followed the incision" into the stomach, and was difficult to arrest completely during the suturing of the stomach. Pure blood was vomited on the third day, and about two teaspoonfuls on the sixth. As Mr. Treves points out (*loc. infra cit.*), if care is taken to make the opening in the stomach only large enough to just admit the index finger, it will be securely plugged.

Mr. Treves has published (*Brit. Med. Journ.*, 1889, vol. i. p. 1105) another successful case of this operation. The mischief here, perhaps, arose in a kick from a horse three years before. The pylorus was at first difficult to define. It appeared to be imbedded in a mass of almost cartilaginous hardness, which was firmly adherent to the under-surface of the liver. Not only the pylorus itself, but the stomach as well, for some 3 square inches, was in like manner adherent. The adhesions were inflammatory, and were divided as freely as possible, but it was found impossible to entirely separate the stomach and pylorus from the liver. The pylorus was dilated, first with the index, then the middle finger of the right hand, and finally with both. The recovery was only complicated by an attack of vomiting on the seventh day. The patient was seen free from all stomach trouble a year later.

* However the dilatation is effected, it should be kept up for a few minutes.

† If any cleansing of the peritonæum is required, this will be done now. To prevent any chance of leakage, sutures should be placed at the very angles of the wound, or even beyond them (Fig. 183).

The after-treatment will be much the same as for gastrotomy (p. 910). Prof. Loreta feeds his cases by the mouth very early, if needful—"on the fourth day (Haggard); according to his own paper, on the same evening, in his first case he gave every half-hour teaspoonfuls of the yolk of an egg beaten up with Marsala. The condition of the patient, and the way in which enemata are retained, must decide this point. If the suturing be efficient, a little mill and barley-water with a few drops of brandy may be given six hours after the operation.

PYLOROPLASTY.

This is a scientific advance on Prof. Loreta's operation for the relief of non-malignant strictures of the pylorus, *e.g.*, those due to corrosive poisoning, injury, and chronic gastritis. We owe the operation to Heineke and Mikulicz, who performed it independently in 1886 and 1887.

In pylorotomy a definite plastic operation replaces a divulsion performed more or less in the dark. The two operations are very well contrasted by Mr. Pearce Gould in an instructive paper (*Lancet*, 1893, vol. i. p. 1183). "Of the two methods of obtaining a wider pylorus, pyloroplasty was chosen as safer and more likely to be permanently successful than Loreta's operation of divulsion. Both operations entail incision into the stomach and subsequent suture of the wound; so far their perils are the same. But whilst pyloroplasty consists of a clean cut through the anterior wall of the pylorus, where it is most free from large vessels and under the operator's eye, the effects of divulsion are not seen and may be more or less than the surgeon intends, and may be inflicted upon important vessels. The statistics of Loreta's operation show cases of death from complete rupture of the pylorus on its posterior aspect, and also from hæmorrhage; the plastic operation is entirely free from these dangers.* A further most important consideration is the question of relapse. Divulsion has been followed by recurrence of the stricture, and in many cases the operation has been repeated, and looking to analogous cases this is what one would expect. A sudden dilatation of the strictured urethra or rectum is well known to be followed by relapse unless special means are used to maintain the enlargement; all such special means are inapplicable in the case of the stomach. Stretching the pylorus may consist of overstretching the muscular ring, analogous to stretching the sphincter ani—this may be entirely satisfactory in its result; on the other hand, it may effect a tearing and stretching of fibroid or cicatricial tissue—a process known to be very unsatisfactory in many cases. Pyloroplasty, on the other hand, introduces new and presumably healthy tissues into the pyloric ring, tissues with no tendency to contract. In this connection it is interesting to remember the results obtained by the free division of the palmar fascia in Dupuytren's contraction. Not only is the shortened fascia lengthened, but the indurated tissue softens down and all signs of the malady may disappear."

Operation (Fig. 245).—The preliminary treatment as to diet, and washing out the stomach is that given at p. 919. The abdomen having been opened by a free incision either in the linea alba or semilunaris, and all hæmorrhage stopped, the pylorus is found, brought out of the wound if possible, and in any case well packed around with tampons of iodoform gauze or sponges wrung out of carbolic acid lotion (1 in 20). Adhesions between the pylorus and omentum, or between

* Mr. P. Swain, of Plymouth, whose operative experience is well known, has candidly published (*Lancet*, 1892, vol. i. p. 87) two cases of digital dilatation of the pylorus which ended fatally. Both patients were in very weak condition: one died of continued vomiting. In the other, the duodenum, which was very thin, was torn quite through, behind, at its junction with the pylorus.

pylorus and the liver, may need separating. A transverse incision is then made into the anterior wall of the stomach just internal to the pylorus, by which the stricture is examined from within. The incision is next prolonged transversely through the strictured pylorus into the duodenum, making it about two inches long. Any vessels which spirt must be clamped. Any contents of the stomach which may escape are carefully removed on gauze. The transverse incision is then widely opened out by two blunt hooks, placed in the centre of each side; this produces a wound of lozenge shape, which is united so as to form a vertical one. Any soiled sponges or tampons being renewed the sutures are inserted in a double row. There are several ways of doing this. A continuous suture uniting

FIG. 245.



Pyloroplasty shown diagrammatically. Above the stomach, to the left hand of the figure, shows a linear incision in the contracted pylorus; in that to the right the viscus is shown at the completion of the operation. Below are shown, from left to right, (1) the linear incision in the pylorus; (2) the same dilated; (3) the incision with its upper and lower angles retracted and with a few sutures in place; (4) the wound as it finally appears when closed. (Esmarch and Kowalzig.)

the mucous membrane and a row of Lembert's sutures (Fig. 183) carried well into the muscular coats would be simple and efficient. Fine silk should be used on ordinary round sewing needles. To strengthen the line of suture any tags of peritoneal adhesions which have been separated and left attached near the incision may be brought together and fixed over it by a few points of suture. The after-treatment will be that given at p. 914.

Successful cases will be found recorded by Mr. Page of Newcastle (*Lancet*, 1892, vol. ii. p. 84); Mr. Gould, *loc. supra cit.*; Mr. Morison (*Lancet*, 1895, vol. i. p. 396). Mr. Gould quotes several foreign operators, and, having collected twenty-three cases, finds the mortality to be about 25 per cent. Mr. M. Robson (*Brit. Med. Journ.*, 1895, vol. ii. p. 124) in two successful cases made use of his decalcified bone-bobbin (p. 836). This, besides steadying the line of sutures for twenty-four or forty-eight hours, secures an immediately and thoroughly patent channel. It is not stated whether any difficulty was met with in inserting the bobbin.

PYLORECTOMY. EXCISION OF THE PYLORUS.

This operation, which we owe especially to German surgeons—*g.*, Billroth, Wölfler, Gussenbauer, and v. Winiwarter—has never been definitely accepted in English surgery. The very high mortality and the rapidity of recurrence have led surgeons to turn to such operations as gastro-jejunostomy, and in a few cases—too

few at present—to the combined operations of pylorotomy and gastro-duodenostomy. At first sight the very high mortality and the very brief duration of cure would appear to utterly condemn pylorotomy.

Winslow (*Amer. Journ. Med. Sci.*, 1885, N.S. vol. lxxxix. p. 345) collected fifty-five cases in which pylorotomy was performed for cancer. Of these, forty-one died from the effects of the operation, giving a mortality of about 76 per cent. Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 217) quotes Bramer (*Cent. f. Clin.* 1885, p. 548) as having collected seventy-two cases of pylorotomy for cancer of which fifty-five died from the operation, a mortality again of about 76 per cent.

Duration of Cure.—Mr. Butlin (*loc. supra cit.*) shows that all the cases which have been properly reported were either dead or suffering from recurrence. A single case died in a period of from four to eighteen months. The exception was one of Wölfler's, which remained well for a year, and then had recurrence in the cicatrix, which was operated on. Later on the groin glands became affected and four years after the pylorotomy the patient was dying slowly of cancerous recurrence. In Mr. Butlin's words, "There is not one, therefore, of those who recovered from the operation who can be claimed to have been really cured of the disease. . . . Yet the cases in which recovery from the operation took place were, so far as could be judged, singularly favourable for the operation. In the very large majority of them the disease, which was very limited in extent, was not complicated by adherence to the surrounding parts, while the glands, as far as could be seen, were not affected by the cancer."

Mr. Butlin goes farther when he states his belief that, while no patients have been cured by this operation, the relief it gives is not likely to be abiding, as the recurrence in several has taken place *in situ*, and as this causes as much suffering as the primary disease.

With regard to statistics, it may, I think, also be remarked—(1) that a very large number of these cases have been treated by hands especially practised in this operation, and yet the mortality is extremely high; (2) that the statistics do not give the whole mortality, as it is highly probable that a large number of operations have been performed with unsuccessful results, and therefore have not been published.

But, in justice, the above most unfavourable opinion requires qualification. It must be remembered that the results on which it is based are, in great measure, due (1) to the method employed having been that of end-to-end direct union by suture, necessarily prolonged even in skilled hands, and always risky from the difficulty in adapting the larger stomach end to the smaller duodenum (2) to very many of the cases having been quite unfit for such an operation as pylorotomy, and only having been submitted to it because at that time there was no approved alternative operation such as gastro-jejunostomy. It is certain that a more careful selection of cases, resort to operation earlier, and an employment of modern methods, which will replace the tedious suturing, such as the use of bobbins, buttons, &c., or the resort to the combined operations of pylorotomy and gastro-duodenostomy, will largely reduce the mortality, while it is equally certain that gastro-jejunostomy instead of or without a pylorotomy does not usually afford any great prolongation of life, though it alleviates the close of it, often to a marked degree.

In support of the above more favourable opinion, I would quote Prof. Kocher's views as to pylorectomy:*

"The longest period during which life can be prolonged and rendered tolerable, after a palliative operation, is but a little over a year. The results after resection of the pylorus are quite different. Among the recorded cases is one in which the operation was performed by Wölfler, and in which the patient lived $5\frac{1}{4}$ years after the operation. This is the longest period of survival up to the present time. During five years of this time the patient had no digestive derangement and no local recurrence. She died from glandular recurrence around the portal fissure and in the iliac fossa. The stomach was normal in form and size; the peptic glands were absent from the neighbourhood of the scar, but the mucous glands and the muscular bundles were well preserved. There was no recurrence in the stomach itself. Rydygier reported the case of a woman who died of recurrence $2\frac{1}{2}$ years after the operation, having been entirely free from complaint for years. . . . As a permanent recovery has not been published up to the present, we consider it especially valuable to record a case in which the operation was performed five years and four months ago, and in which there is at present no sign of recurrence; on the contrary, the patient (the mother of a medical man) enjoys perfect health, and can take pretty well any food."†

Before deciding between, on the one hand, a pylorectomy, either alone or combined with gastro-duodenostomy, and, on the other, a gastro-jejunostomy only, the following conditions must be most carefully considered:

i. The size, fixity, and degree of displacement of the pyloric growth. Is the mass small, circumscribed, and localised to the pylorus?—*i.e.*, how far is it (a) without any secondary deposits? (β) free from adhesions? It is probably quite impossible to be certain as to these points. While in many cases cancer of the pylorus may remain long limited to the pylorus itself, it is very liable to infect the omenta, the lymphatic glands around the head of the pancreas, and to cause secondary growths in the liver and other parts.‡ Adhesions, too, are very frequently § met with between the stomach and the colon, pancreas, and liver. The

* They are taken from the translation of the third edition of his *Operative Surgery*, p. 132, by Mr. Stiles of Edinburgh, 1895. The date of the German edition is not given.

† This most successful case of Prof. Kocher's was operated on by his method given below (p. 923). It is not stated how the one of Wölfler's which also survived so long, was performed.

‡ McArdle (*Dublin Journ. Med. Sci.*, vol. lxxxiii. p. 511), having collected from the statistics of different writers 1342 cases, states that the pylorus alone was involved in 802, or over half the cases.

§ The statistics of Gussenbauer and Winiwarter (*Langenbeck's Arch.*, Bd. xix. p. 372, 1876) show that, of 542 cases of cancer of the pylorus, adhesions were present in 370.

following cases show how easily the surgeon may be mistaken in these points. In Mr. Southam's patient (*Brit. Med. Journ.*, July 29, 1882—an instructive paper, from which I shall again quote later), aged forty-three, though the hard nodular mass in the situation of the pylorus moved with respiration, and shifted as the patient moved from side to side, though the symptoms were only of four months' duration, and the disease appeared to be limited to the pylorus, there was a mass of enlarged glands surrounding the head of the pancreas, and some slight adhesions of the stomach to these. Mr. Morris mentions a patient of Prof. Lietherin's in whom, though the growth could be easily moved in different directions, it was found so firmly adherent that the operation had to be abandoned.

ii. The strength and age of the patient. The general condition, power of repair, &c., must be sufficient to justify the patient being submitted to an operation on very vital parts, which will certainly take an hour and a half, and may take between two and three.

iii. The rate at which vomiting, pain, and emaciation are increasing. Where this is marked, pylorotomy should be abandoned.

iv. The amount of dilatation of the stomach, and how far this yields to washing out.

Where the surgeon remains in doubt as to the advisability of pylorotomy up to the time that the abdomen is opened, the presence of adhesions between the stomach and adjacent parts, liver, pancreas, &c., the existence of secondary deposits or enlarged glands, the extension of the disease into the omenta—if any of these are present—pylorotomy should be abandoned.

If pylorotomy be decided upon, the following methods may be adopted:

i. **Pylorotomy, with direct suture of the divided ends.**—Owing to the time this method takes, it is not to be recommended. It will be described out of respect to the Continental surgeons who have acted as pioneers in this direction, and also because two recent successful cases have occurred lately.* ii. **Pylorotomy, the ends being directly united by some such means as Senn's plates or Robson's bobbin.** iii. **Combined Pylorotomy and Gastro-duodenostomy,** these operations being performed at the same sitting and consecutively. iv. **Pylorotomy and Gastro-jejunostomy in two stages.** Here the gastro-jejunostomy is performed first and the pylorotomy a few days later.

i. **Pylorotomy, with direct suture of the divided ends.**

* One by Dr. MacCormick, of Sydney (*Brit. Med. Journ.*, 1892, vol. i. p. 553). The stomach was partly closed with silk Lembert's sutures, and the remainder of this viscus united to the duodenum by a double row, ninety-eight sutures being used between the two viscera. The operation took about two hours. Feeding by the mouth was begun two days after the operation. A good recovery followed. The second case is published by Dr. Adams, of Glasgow (*Brit. Med. Journ.*, 1896, vol. i. p. 966). Here only a single continuous Lembert's suture, of chromic gut was used, both to close the superfluous part of the stomach and to unite the two viscera. The operation took an hour and was entirely successful.

Operation.—For some days before the operation the stomach should be washed out with tepid water, syphon-fashion, by an india-rubber tube and funnel, till the contents come out clear, this being done more frequently according to the degree of dilatation of the viscus. Immediately before the operation * the stomach is again washed out with some dilute aseptic solution, as well diluted salicylic acid, or boro-glyceride (1 in 30), or potassium permanganate. For some time beforehand the patient must be fed with that food which is found to cause least vomiting. In Mr. Southam's case this was found to be peptonized milk and custard.† The bowels will be well cleared out with enemata, and every precaution at the time of the operation should be taken against shock—viz., wrapping up the patient well, a hot-water bed, hot bottles, bandaging the limbs in flannel, keeping the head low, the administration of ether if possible, or A.C.E., for the greater part of the operation, and subcutaneous injections of ether and brandy.

Various incisions have been made—viz. : (1) A vertical one in the linea alba, above the umbilicus. (2) A vertical one in the right linea semilunaris, or through the rectus, separating its fibres so as to avoid hæmorrhage (p. 900). (3) Obliquely from above downwards, and from within outwards, between the umbilicus and right ribs. (4) More transversely over the tumour. Either of the last two gives more room, and thus better access to the growth. But as both are accompanied with more hæmorrhage, and are much more difficult to close‡—a point which may be of much importance at the close of such an operation—they should not be made use of. Suture of a divided retracted rectus is most embarrassing if there be any distension of the abdomen. All hæmorrhage having been first arrested, the transversalis fascia and peritonæum are pinched up and opened so as to admit two fingers, which examine the growth; the presence of adhesions or enlarged glands; invasion of the liver, pancreas, or colon, or curvatures of the stomach itself. If the disease is so localized as to allow the surgeon to go on, the opening in the peritonæum is enlarged so as to get a better view of the disease, and to enable the mass to be drawn forwards with vulsellum-forceps. This having been done as much as possible, the stomach is packed around with hot carbolized towels or sponges, so as to prevent any escape of fluids into the peritonæal sac. The omenta are next separated § with scissors, either between double ligatures of chromic gut previously passed with an aneurism-needle, or between large pairs of omental clamp-forceps; the tissues being very thin it is not necessary to take much time in tying them bit by bit. Any suspicious lymphatic glands must be removed.

Excision of the Diseased Pylorus.—Previous to this, iodoform-gauze tampons or sponges should be still more carefully packed around the stomach,|| and the duodenum should be secured, either with some form of clamp (Fig. 212), or by a strip of iodoform-gauze clamped, or by an assistant's fingers, wide of the disease. The duodenum is then cut through, as in Fig. 246, with scissors, at least half an inch from the disease. This incision, oblique, so as to diminish as far as possible

* In Mr. Southam's case the need of this final washing was proved by the fact that a quantity of dark-coloured grumous matter was brought away, which otherwise might have escaped into the peritonæal sac.

† If possible, the only food taken by the mouth for twelve hours before the operation should be champagne or Valentine's meat-juice.

‡ In Mr. Southam's case, the incision, 6 inches long, was made 2 inches above the umbilicus, and across both recti; the contraction of these muscles led to much difficulty in adjusting the abdominal wound.

§ Care must be taken only to detach the omenta over the area corresponding to that which is to be removed.

|| It will add greatly to the safety of the operation if the pylorus can be so drawn out of the wound that a flat sponge can be placed within the peritonæal sac, and iodoform gauze packed around the now isolated pylorus.

the difference in the openings in the stomach and duodenum, is made with a series of clean, careful snips, any bleeding points being secured at once with Spencer Wells' forceps if few, and with fine chromic gut if numerous. Any fluid

FIG. 246.*

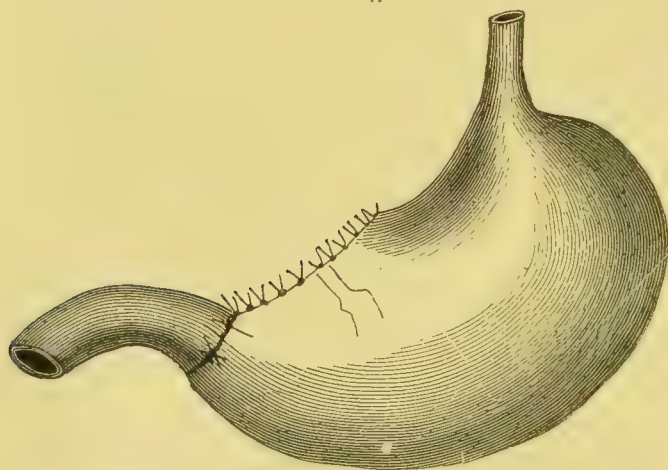


Oblique division of the stomach and duodenum in pylorotomy. Billroth in this case made half the division of the stomach first, united this with "occlusion sutures," next severed the rest of the stomach, then the duodenum, finally uniting this to the greater curvature. (Billroth.)

him a useful hold on the viscera he is uniting. Dr. Adams (*loc. supra cit.*) found that a free removal of the mucous membrane from the edges of the wound greatly facilitated uniting them.

The section of the stomach has been made in different ways. The most usual one is shown in Fig. 246. The section is made

FIG. 247.



Duodenum united to the greater curvature; ten occlusion sutures unite the upper part of the cut stomach. (Billroth.)

curvature, or to the part between the two.† In the former case he cuts the stomach from above downwards, and from left to right, and it will be well to unite that part of the stomach which will be

which escapes must be mopped up with sponges, and one of these, fastened to string may be introduced into either viscus, if it will facilitate the suturing. This step may also be rendered easier by dividing the stomach only partially at first, suturing this part and then completing the division. All the sutures should not be cut short as tied; if the operator leaves some long (clamped in forceps, so as not to be in the way) it may give

obliquely, with the precautions already given in the case of the duodenum. As the cut end of the stomach is so much larger than that of the duodenum, the former must be reduced by suturing part of it before it is completely divided. The surgeon will decide whether he will unite the duodenum to the greater or lesser

* This and the next four figures are taken from Prof. Billroth's *Clinical Surgery*, pt. iii.

† Prof. Billroth prefers uniting the duodenum to the greater curvature.

superfluous before the section is completed (Fig. 247). The same course is followed if the duodenum is united to the lesser curvature; but here the section is made from below upwards, and from right to left. Figs. 248, 249, show the mode of uniting the duodenum midway between the two curvatures.

Closure of the Stomach, and Union of this and the Duodenum.—

That part of the stomach which is superfluous is closed with carbolized-silk sutures, inserted by Lembert's method, the sutures being left long and held in forceps, so as to

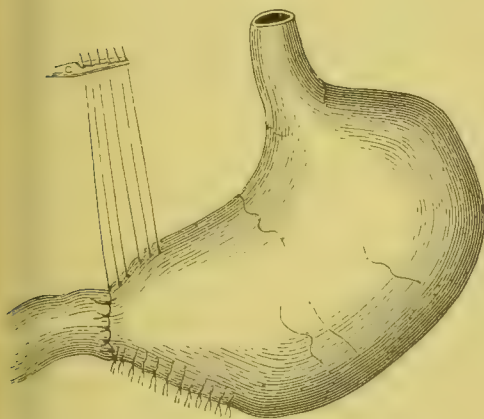
steady and move the stomach and thus facilitate its union with the duodenum. The clamp on the latter being removed, it is united to the greater or lesser curvature, or centre, as follows, beginning with sutures passed from within (Fig. 250). These, of fine carbolized silk, are passed with a needle in a holder, first at the cut edge of the stomach between the mucous and muscular coats, carried on

FIG. 248.



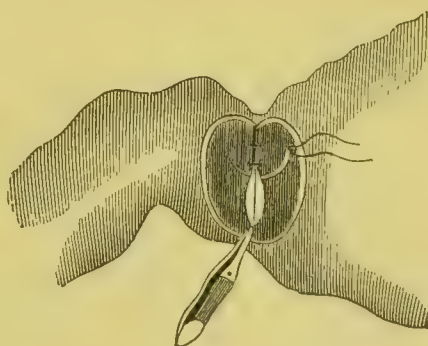
(Billroth.)

FIG. 249.



(Billroth.)

FIG. 250.



Insertion of the posterior ring sutures from within. (Billroth.)

between the muscular and serous then through the same layers of the duodenum, and finally brought out between these layers and the mucous membrane at the cut edge of the duodenum. When the posterior aspect of the two viscera is thus soundly closed, the anterior one is united by Lembert's suture. The needles employed are fine curved ones for the sutures inserted from within, and round straight ones, No. 5, for the rest. If there is any doubt as

to the security of the sutures, an omental graft may be used (Figs. 219 to 221). Dr. Adams employed one of these in his case (p. 918), where he employed but one row of catgut sutures.

Care must be taken in inserting the sutures to avoid the formation of any folds (Billroth). The same surgeon says it is well to put a few additional superficial sutures at the point where the borders of the duodenum join those of the stomach. If the stomach contains fluid in spite of the washing out, it must be mopped dry, with carbolized sponges kept for this purpose alone, and it may be a help to introduce sponges tied on to silk into the cut ends while the sutures are being inserted, withdrawing them before the stitches are tightened. The sutures being carefully looked over and cut short, a little iodoform is rubbed in, the sponges or towels removed, and the stomach replaced. If any fluids have escaped into the peritonæal sac, this must be carefully cleansed (p. 816). The abdominal wound is then closed in the usual way and the dressings applied.

After-treatment.—This will be conducted on much the same lines as after gastrotomy (p. 910). Mr. Butlin (*loc. supra cit.*) points out that these patients, much let down and exhausted, will not last long on the administration of ice and nutrient enemata only. After the first twenty-four hours teaspoonfuls of milk, Valentine's meat juice, raw beef juice, barley water, and a few drops of brandy or champagne, should be given, at first, every half-hour or hour, and gradually increased up to two pints in the twenty-four hours at the end of a week.

ii. **Pylorectomy**, the ends being directly united by some such means as Senn's plates, Mayo Robson's bobbin, &c.—By this means the time consumed by direct suturing is considerably shortened. Dr. Rawdon of Liverpool was, I believe, the first in this country thus to improve the technique of pylorectomy (*Brit. Med. Journ.*, 1890, vol. i. p. 323).

After division of the omenta (*vide supra*, p. 919) and resection of the diseased pylorus, the stomach-opening was partially closed by a continuous silk Lembert's suture, commencing at the lesser and stopping one inch from the greater curvature, thus leaving an opening large enough to admit a Senn's plate cut circular. A similar plate was introduced into the duodenum, all four silk threads being passed through the walls a short distance from the cut edges. The case recovered and lived for five years, nearly four of these being passed in perfect health. Three years and eight months after the operation hæmatemesis occurred, followed six months later by dyspepsia and a small swelling under the cicatrix which steadily increased. At the autopsy nearly the whole of the stomach was occupied by a large ulcer. There were no secondary growths. The close of the case is given (*Lancet*, July 13, 1895) by Dr. W. H. C. Davey, to whom we are also indebted for the account of Dr. Rawdon's operation.

Mayo Robson's bobbin will be an improvement on the above method. Full directions for its use in end-to-end junctions are given at p. 836. But though by the above mechanical means the lengthy process of suturing will be rendered shorter and safer, the difficulty of adjusting securely the larger stomach end to the

smaller duodenum still remains, and for these reasons I prefer the operation which follows.

iii. **Combined Pylorectomy and Gastro-duodenostomy, the two operations being performed at the same time.**—This double operation, though at first sight severe, has the following great advantages over a pylorectomy performed by direct suture or a gastro-jejunostomy alone. It affords an opportunity of attempting to remove the disease by the pylorectomy, while the gastro-duodenostomy greatly shortens the time consumed, and, preceded by a pylorectomy, facilitates making the junction to the posterior wall of the stomach, thus promoting drainage of the latter. It is by this method that Continental surgeons have secured results so superior to our own; Kocher of Berne having had 8 cases successful out of 10, and Lücke of Strasbourg 7 successes running.

(A.) **Combined Pylorectomy and Gastro-duodenostomy by Kocher's method of suture only.**—The following account is taken from Kocher (*Operative Surgery*, trans. by Stiles, 1895, p. 134). All the eight cases operated on by this method healed completely. A central incision, 4 to 6 inches long, is carried downwards below the umbilicus for a distance corresponding to the position of the tumour. The umbilicus is excised and all hæmorrhage arrested. The tumour is next drawn out as far as possible, and its limits carefully determined. The omenta are separated above and below over an area corresponding to the amount to be removed. This separation should run as close to the stomach as is consistent with complete removal of the disease, and is effected by the finger or a blunt instrument, all bleeding points being ligatured. After isolating the tumour, sterilized gauze is passed beneath it and around the duodenum and stomach, so as to prevent their contents reaching the interior of the abdomen. A clamp (*vide* pp. 858, 923, 925) is now placed upon the duodenum close to the edge of the tumour, and two (these being in line, one from above and the other from below) upon the stomach, well to the gastric side of the tumour. The clamps are large artery forceps, closed by the usual catch. They may be closed without hesitation, as there is no danger of causing necrosis of the gastric or intestinal walls. A second clamp is placed upon the healthy duodenum parallel to and beyond the first, and the intestine is then cut across between them. The edge of the gut which projects beyond the clamp is thoroughly disinfected by means of a small swab soaked in a 1 in 1000 sublimate solution. The divided duodenum towards the side of the growth is merely wrapped round with sterilized gauze and lifted out with the growth; the other end of the duodenum is folded over the right margin of the wound and covered provisionally with moist gauze. The assistant now grasps the stomach from above and below between the forefinger and thumb, or between the index and middle fingers of each hand, in order to close it securely; and after placing a ring of gauze over the hands of the assistant and round the stomach, the surgeon cuts

across the latter well to the cardiac side of the two clamps. The new growth is laid aside, and, after any escaped gastric contents have been swabbed up, and the more important bleeding vessels secured, the stomach is closed by a continuous silk suture which penetrates *all three coats*. The projecting edges of the mucous membrane are thoroughly cleansed with sublimate solution. The continuous deep suture is then invaginated, and a continuous Lembert's suture carefully applied, so as to keep the serous coats, reliably and completely approximated in their whole extent. Any gauze which is soiled having been changed, the assistant grasps the stomach so as to direct its posterior wall forward and to the right. The posterior wall of the duodenum (with the forceps still clamping it) is now applied to the posterior wall of the stomach in such a way that *a continuous posterior serous suture* may be comfortably introduced between it and the stomach from the upper to the lower edge of the intestine. It is only now that the forceps are removed from the duodenum. The escaping contents are thoroughly removed and the lumen disinfected. Ligatures are applied to any bleeding points. The stomach is next incised about $\frac{1}{4}$ inch from the posterior serous suture for a distance corresponding to the opening in the duodenum.* *Another continuous posterior suture* is next introduced, this one taking up all three coats. The ends of the posterior sutures, which have been left long, are now re-threaded and employed in succession for the *anterior sutures*, the order being reversed. The protecting gauze having been removed, the lines of suture are again thoroughly disinfected, the stomach and intestine replaced, and the wound closed. Instead of uniting the cut end of the duodenum into an opening in the stomach, the surgeon, after a free pylorotomy, might close the end of the duodenum as well as that of the stomach, and then unite the viscera by Halstead's or some other method (p. 875).

Kocher emphasizes the following points as essential to success: (1) The operation must be performed *aseptically*, and the greatest care must be taken to avoid the entrance of disinfectants into the abdomen. Sublimate and its substitutes must only be used to disinfect the lines of suture and those areas of peritonæum which have been directly contaminated by the gastro-intestinal contents. Kocher thinks that collapse is often due to the too free use of such disinfectants. Even during a very prolonged operation, salt solution should be employed exclusively for the swabs and all the gauze placed around the wound. To prevent the entrance of gastro-intestinal contents, it is essential to use plenty of soft gauze. (2) As advocated by Rydygier and Lauenstein *all the sutures*, the superficial serous, and the deeper, which take up the whole thickness of the wall, *must be continuous* and without the least interruption from one end of the wound to the other; this is why Kocher so strongly urges leaving the ends of the posterior sutures long after knotting them, so that they may be again reliably knotted with the anterior sutures. A perfectly secure closure is thus attained, and there is not the slightest necessity to prove that the suture is water-tight.

* The intestine is held vertically against the stomach while it is being sutured, and the opening in the stomach is made vertically also.

by distending the intestine. Another reason for carrying the continuous suture through the entire thickness of both gastric and intestinal walls is that only by this means can reactionary hæmorrhage, which has been the cause of a certain number of fatal cases, be prevented with certainty. Fine strong silk must be used for the sutures, not the less reliable catgut. Kocher has not seen any of the disadvantages ascribed to silk. He considers that Senn's method is more complicated than his own, and that its results have not quite fulfilled expectations. (3) *The employment of clamps.* Kocher considers these absolutely necessary for the closure of the cancerous portion, both on the duodenal and the gastric side. It is only in this way, as he has pointed out (*Centr. f. Chir.*, 1883, No. 45), that the dangerous escape of cancer juice can be prevented with certainty. The clamps have the following additional advantages—viz., that the intestine, and more especially the stomach, can be cut across along an exact line at the place desired, a matter which is otherwise not always easy. Further, the use of clamps greatly shortens the operation. They produce complete closure, and serve as convenient handles for drawing up and manipulating the parts. They increase the possibility of completely disinfecting the cut edges immediately after the section by preventing their slipping back. Lauenstein's objection that they necessitate removal of additional sound tissue is hardly a disadvantage, as the prospect of a permanent cure is thereby increased. As to other disadvantages Kocher is convinced that they cause no necrosis if the operation be properly and aseptically performed. He has no hesitation in applying a clamp to the healthy part of the duodenum where it is afterwards to be stitched.* In his use of clamps Kocher applies no elastic covering after the manner of Gussenbauer, nor does he use the elastic bands of Rydygier. He merely clamps them firmly enough to thoroughly close the intestine and stomach, and has observed that the edges of both bleed actively as soon as the clamps are removed. Finally, Kocher denies that the clamps, by requiring unnecessary room, necessitate a needless separation of the mesentery as stated by Lauenstein.

(B.) **Combined Pylorectomy and Gastro-Duodenostomy by Senn's Plates.**—If this method be made use of, the liability of the opening to close, which has been noticed so frequently after the employment of plates, must be remembered. An excellent account of this method is given by Mr. Jessett (*Lancet*, Oct. 24, 1891; *Surg. Dis. of the Stomach and Intestines*, p. 33). Mr. Jessett recommends saving time by securing the vessels which run along the curvatures with an aneurysm-needle carrying chromic gut, then tying the great omentum, securing this by transfixing it like an ovarian pedicle, and tearing through the lesser one, the thinness of these structures rendering it needless to resort to the tedious process of tying them piece by piece. As there was a quantity of fluid still present in the stomach, Mr. Jessett syphoned this off.† The ends of the stomach and duodenum were secured with a continuous suture internally and Halstead's quilt sutures (Figs. 185, 230) externally. Broad ligament forceps were used on either side of the growth as clamps. When the time came to make

* The closure of the cardiac side of the section of the stomach must be effected merely by the hands of an assistant.

† When the fluid present in either viscus is small in amount it may be caught on sponges before the mucous membrane is cleansed. If any sponge is introduced into the stomach to soak up fluid and to facilitate suturing, it should be secured on silk. Dr. Bull of New York, with most praiseworthy candour, relates a case (*New York Med. Journ.*, 1891, vol. i. p. 42) in which, fifteen hours after the operation, leakage followed, causing fatal peritonitis. A finger had been introduced into the stomach and the count of the sponges declared correct, but one, concealed in the cardiac end, had escaped the finger and had, later on, been forced by peristalsis against the sutures.

the sections, that through the stomach was made between the upper clamp and an assistant's fingers, that through the duodenum between the lower clamp and a piece of tubing clamped with Spencer Wells' forceps.

(C.) **Combined Pylorectomy and Gastro-Duodenostomy by means of a Murphy's button.**—Full directions for the use of this instrument are given at pp. 840, 873. Gastro-enterostomy and the following special directions for the combined operation will be found given by Dr. Murphy (*Lancet*, 1895, vol. i. p. 1041):

The omenta above and below are tied in broad pedicles between three or four double ligatures and divided, the pylorus can then be lifted well up into the wound. Gauze having been then well packed around, two clamps are placed on the stomach, one above and one below * the spot to be divided. A circular incision is next made in the stomach, including the serous and muscular coats, these are reflected for half an inch and the mucous coat cut through. The latter coat is then closed with a continuous, and the serous and muscular coats with a continuous Lembert's suture. The duodenum is next divided between two clamps, and the edges treated like those of the stomach. Finally, one half of the button having been placed in the duodenum and the other in the posterior wall of the stomach, one inch from the line of suture, the two are pressed together and the stomach returned. Four cases are given with three recoveries. In all the latter the button was passed. It will be noticed that the duodenum was united to the back of the stomach, a step which is rendered easy by the previous pylorectomy and which promotes the passage of the button.

(iv) **Pylorectomy and Gastro-Jejunostomy in two stages.**—M. Quénu (*Rév. de Chir.*, Oct. 1895) recommends this step. The gastro-jejunosomy performed first not only shortens the time required for the pylorectomy, but improves the nutrition of the patient. The use of a Murphy's button is advised.

GASTRO-JEJUNOSTOMY.†

The object of this operation is to make an opening between the blocked stomach and the small intestine as high up in the latter as possible, so that the food may still find its way into the intestine and there meet with the other digestive fluids.

Indications.—It may be made use of in malignant ‡ disease under the two following conditions chiefly: (i) *Together with pylorectomy* (p. 923).—This is always to be preferred when the patient's condition admits of it, and the surgeon decides not to attempt an end-to-end union. This combination of operations has given good results (p. 923); it enables us to attempt the removal of the disease, and at the same time greatly shortens the pylorectomy.

ii. *Alone.*—This is a very inferior operation to those of pylorectomy or pylorostomy and gastro-duodenostomy combined. If all the cases of gastro-jejunosomy which have been performed had been published it is certain that the results both

* Any pressure-forceps will suffice on the side nearest the disease.

† To be accurate the term Gastro-jejunosomy should be used for union of jejunum to stomach, gastro-duodenostomy for union of duodenum and stomach after a pylorectomy (p. 923). The term gastro-enterostomy, which has been carelessly used for either of the above operations, should be dropped. In future, writers should specify which operation they refer to.

‡ Gastro-jejunosomy has also been employed in cases of stenosis of the pylorus not of a malignant character. In my opinion pyloroplasty (p. 914) or Loreta's operation (p. 912) are to be preferred.

as regards the immediate mortality and the duration of life would be most disappointing. This is no doubt due to the fact that the operation has been much too often performed in very emaciated patients, quite unfit to bear a prolonged operation and to supply a necessary plastic repair. For the future, gastro-enterostomy or, as it should be here more correctly called, gastro-jejunos-tomy, should be reserved for the following cases: (1) where the malignant disease extends too far into the stomach, or where it is too fixed—*e.g.*, to liver or pancreas—to make a pylorotomy, either alone or with a gastro-duodenostomy, justifiable; or where secondary deposits and enlarged glands can be felt. (2) The cachexia and emaciation* of the patients must not be so marked that it is very doubtful whether they will survive an operation that may be prolonged, and which must be severe, in that it entails the handling of very vital parts, and one which for its success entails a certain adequate amount of plastic repair.

If the operation be carefully reserved for the above cases it will be called for less frequently than of late years, but will be found in these to give great relief. If surgeons continue to perform it, as gastrotomy has been too often performed, for malignant disease of the œsophagus, in cases where the operation comes too late, their patients, if they survive, will do so for a very short time, succumbing to the effects of a marasmus so established as to be unalterable. Dr. Murphy of Chicago goes further (*Lancet*, 1895, vol. i. p. 1040): "It is my opinion that patients who are not in a condition to stand a pylorotomy† should not be operated upon. The relief obtained, even when gastro-enterostomy is successful, is so limited that it does not justify the danger and discomfort produced by the operation, notwithstanding that the operation can be performed with the button in from five to seven minutes. These patients suffer much more from shock in operation than those with non-malignant disease, and the regenerative power of the tissues with malignant disease is much impaired."

Operation.—The preliminaries are the same as those already given for pylorotomy (p. 919).‡ The abdomen having been opened the next point is to make sure of finding the jejunum as high up as possible. The omentum§ and colon having been pushed upwards and to the right, the duodeno-jejunal junction must, if possible, be seen as well as felt where it emerges under the pancreas close to the vertebral column; these last two being good landmarks to feel for. || This is one of the essential points in the operation. If the piece of small intestine which emerges below the colon be chosen, it may prove to be low down in the ileum. If the wrong end of the small intestine be thus attached to the stomach, the food taken will not be subjected to the natural processes of digestion and absorption and the prolongation of life will be brief. The importance of the above is proved by the fact that the above accident has occurred to operators of such experience as Mr. H. W. Page (*Med. Chir. Trans.*, vol. lxxii. p. 379).¶ Here the intestine attached to the stomach was the ileum, nine inches

* Instances which do and which do not justify gastro-jejunos-tomy would be cases where, on the one hand, the loss has been only two pounds in several months, and, on the other, that of a stone in a week or two.

† By this is meant a pylorotomy shortened by the combined operation of a gastro-duodenostomy (p. 923).

‡ Some Continental surgeons, in order to avoid the risk of after-vomiting, have made use of cocaine only. In an operation like this, of uncertain length, and requiring absolute stillness, general anæsthesia is certainly to be preferred.

§ This being usually thin and wasted gives but little trouble.

|| This method is usually preferable to tracing the jejunum down from the duodenum. The identification of the jejunum high up will be much facilitated by securing an empty condition of the intestines beforehand.

¶ This paper, one of the earliest English ones on the subject, will repay careful

from its lower end. This patient lived for ten weeks, and though greatly relieved from vomiting and nausea, began to lose ground at the end of six weeks. Mr. Page quotes some other cases, a striking one being that of Lauenstein (*Centr. f. Chir.*, 1888, p. 472). Here the intestine opened was only fifteen inches from the ileo-cæcal valve. The patient began to have diarrhoea on the fourth day, passed unchanged food in her stools, and died on the eleventh day.

The jejunum having been made certain of, high up in its course,* it may be united to the stomach by one of the following methods: (1) **Suturing alone.** (2) **Senn's plates.** (3) **Murphy's button.** (4) **A decalcified bone bobbin.** Of the above the first three have been largely tried. Of the different methods of suture alone, I think Halstead's should be preferred, as giving a very large opening with ample margin for contraction and a very efficient suture. Senn's plates simplify the operation greatly; but it is certain from the cases recorded that the opening is liable to contract most seriously later on. Murphy's button has scored very brilliant successes; it is the simplest and quickest of all the methods, and may be resorted to when the patient's condition does not justify any more prolonged method such as suturing. As I have, however, stated in the account of enterectomy, the very simplicity of this most ingenious instrument has led to its being largely resorted to, and I am of opinion that there are a considerable number of cases in which it has not been successful, and which have never been reported. The decalcified bone-bobbin has not yet been sufficiently used in gastro-jejunostomy for a definite opinion to be given; but judging from its success in operations on the intestine, and its numerous proved advantages, I expect to see it come largely into use here also.

(1) **Gastro-jejunostomy by Suture alone.** (A) **Halstead's Method.**—This has been figured and described at p. 876. Mr. Bidwell brought a case of gastro-jejunostomy, performed in this way, before the Clinical Society (*Trans.*, 1894, p. 11). The following is taken from his account of the operation: "A portion of the jejunum was held in contact with the anterior wall of the stomach near the cardiac end, both being brought outside the wound and packed around with sponges. Six quilt sutures (Fig. 230) were then passed between the jejunum, half an inch from its mesenteric attachment and the anterior wall of the stomach. No. 8 straw needles had been previously threaded with No. 9 silk, and a separate needle was used with each suture; the ends of each, when passed, were clamped with pressure-forceps. Great care was taken to pick up and include in each suture some fibres of the submucous coat, as strongly recommended by Dr. Halstead. Three sutures were then passed at the end of this row of sutures and all twelve were then tied and the ends cut short. Six similar sutures were then inserted about five-eighths of an inch in front of the former row, and each was clamped with forceps. An opening about one inch long† was then made into the jejunum and stomach between the two rows of sutures. Some frothy mucus and blood escaped from the stomach, and the growth, which appeared to completely occlude the pyloric orifice, was easily explored by the finger. A point of suture was used to unite the mucous membranes of stomach and jejunum above and below, and the anterior row of quilt sutures were quickly tied, some boracic acid solution was allowed to flow over the part while the sutures were being tied. The anastomosis was now complete." The patient had great relief during the five weeks in which he survived. Mr. Bidwell believes that this method of Dr. Halstead's will effect a more satisfactory union than

reading. The candour and fulness of detail afford a model and example to writers of the present day.

* A sufficient length of the jejunum must be allowed for, so that it can be brought easily round the colon (Fig. 254, p. 934).

† The opening should be much more free, as a rule, for fear of contraction.

Senn's plates without taking much longer in application. Though he had not used the method before, he was able to effect the anastomosis in twenty-five minutes. He draws attention to the need of turning the loop of jejunum half round after it has been picked up, so that, when it is fixed to the stomach, the axes of peristaltic action correspond in the two viscera.

(ii) **Gastro-jejunosomy by (B) Barker's method of Suture alone.**

—While I have stated above why I consider Halstead's method the best, I shall describe an alternative method which has been used successfully. It is that given by Mr. Barker (*Brit. Med. Journ.*, Feb. 13, 1886): "After pushing the omentum, which was not voluminous, to the left, the first part of the jejunum * was caught in the fingers, and a loop drawn out of the incision. The middle of the anterior surface of the stomach † was also drawn out, and supported all round by warm carbolised sponges. I now passed a piece of india-rubber tubing through the mesentery at each end of the loop, and, having emptied the portion of gut by gentle pressure, drew the ends of the tubing tight enough to prevent access of the contents of the bowel into the loop to be operated on, and fixed each piece of tubing with catch-forceps.‡ The empty loop of gut was now laid upon the portion of stomach to be opened, and a longitudinal fold of the latter, about $1\frac{1}{4}$ inch from the great curvature, was pinched up between the finger and thumb of the left hand, together with the collapsed gut. I now made an incision about $1\frac{1}{2}$ inch long in the fold of the stomach, and another corresponding in the approximated fold of gut. These incisions only penetrated through the serous and muscular tunics, and left the mucous coat of both viscera intact for the present.§ Still holding the parts, as before, between finger and thumb, I now united the corresponding posterior edges of the wounds by a continuous suture, the needle entering and emerging in each case between mucous and muscular coats, and the threads crossing the cut edges of the muscular and serous coats. In this way the serous surfaces were closely united from end to end before either viscus was opened. This row of stitches (which were about $\frac{1}{8}$ inch apart) was carried about $\frac{1}{4}$ inch beyond each end of the incision in the coats of the bowel. The moment had now come to open both the stomach and intestine completely, and this was done with a stroke of scissors through the mucous coat in each case, special sponges being ready to receive any fluid which might escape. A few drachms of *succus entericus* flowed from the bowel—little or nothing from the stomach opening. After careful cleansing, the anterior borders of both openings were now united by a row of interrupted fine-silk sutures, introduced according to Czerny's method. When this was completed, the two openings were securely closed, but, as an extra precaution, the intestine was turned over, and the posterior suture was reinforced by a second row of interrupted sutures, placed about $\frac{1}{4}$ inch away from the first. The anterior was then similarly reinforced by a row of continuous sutures taking up, as before, only the serous and muscular tunics. Lest there should be any 'kinking' of the latter, as in one of Billroth's cases, I

* The part actually brought up to the stomach must be about 12 or 15 inches from its commencement, so as to come up without any tension.

† The part of the stomach chosen must always be as far as possible from the disease. And when the stomach walls are thin and atrophied the opening must be as low as possible, as the contents will have to find their way out by gravity alone.

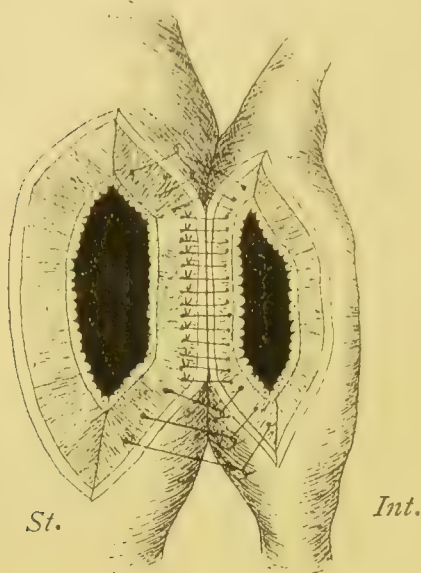
‡ If this method be made use of, care must be taken not to puncture any vein in the mesentery, or most troublesome bleeding will follow. Other modes of clamping the intestine will be found at p. 858.

§ Most troublesome bleeding followed on these incisions, both in the intestine and the stomach, in Mr. Page's case.

stitched its efferent portion to the stomach wall, about $\frac{1}{4}$ inch from the right extremity of the opening between the stomach and jejunum."

Mr. Page made use of similar steps in his operation to which I have alluded. The following excellent drawings (Figs. 251 and 252) are taken from those accompanying his paper. Some sixty silk sutures were used altogether, a row of

FIG. 251.



Gastro-jejunostomy by suture. The posterior edges of the divided stomach and intestine have been united by silk sutures, extending half an inch beyond the openings, at each end. (H. W. Page.)

FIG. 252.



Gastro-jejunostomy by suture. Final union, the anterior lips of the openings in the viscera having been united. (H. W. Page, *Med. Chir. Trs.*, vol. lxii.)

Lembert's stitches having been placed around and about half an inch from the closed opening.

Gastro-jejunostomy by Senn's Plates (Fig. 253).—The use of these has been fully given at p. 869. They have been largely used in gastro-jejunostomy,* and while they, no doubt, have simplified and shortened the operation considerably, it is equally certain that the anastomotic opening thus formed is very liable to contraction afterwards. Thus, in a case reported by Dr. Stansfield of Birkenhead (*Brit. Med. Journ.* 1890, vol. i. pp. 294 and 1300) about eight weeks after the operation the symptoms began to recur, and at the autopsy, two months later, the opening was found to be completely closed. The same thing happened to Mr. Larkin of Liverpool. Here obstruction recurred about eight weeks after the operation, and jejunostomy was performed with much relief.†

It is clear that if these plates are made use of, the edge of the opening should be run round by what the Americans call a "whipping stitch" (Fig. 229).

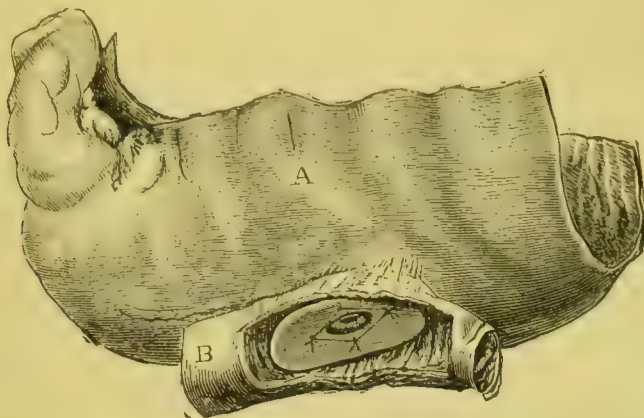
* Amongst others the following papers may be consulted: Mr. Barker (*Brit. Med. Journ.*, 1892, vol. i. p. 63); Jessett (*Clin. Soc. Trans.*, 1892); Allingham (*ibid.* 1893).

† In a note to Mr. Jessett's paper on "Five Cases of Gastro-enterostomy" (*Clin. Soc. Trans.*, vol. xxv. p. 115), it is stated that this patient subsequently died, and that at the autopsy the opening was found to be closed. At the discussion of the papers read before the Clinical Society (*vide supra*), many surgeons had met with the same tendency of the opening made by Senn's plates.

Another means of preventing stenosis has been recommended by Prof. McGraw of Detroit (*Ann. of Surg.*, vol. ii. 1893, p. 313). In order to replace by mucous membrane the scar-tissue which bounds these artificial openings, flaps (X-, H-shaped, &c.) are turned back by cuts made in varying ways. The reflected flaps are retained *in situ* by a few points of fine suture.

Another objection which has been brought against Senn's plates is, I think, of less importance. Long after the plates have disappeared, the ligatures have been found *in situ*. Though months after the operation they have been found

FIG. 253.



Part of the stomach and jejunum from a case of gastro-jejunostomy.
A. Stomach. B. Jejunum. The plate in the jejunum is still seen.
From a specimen in St. Bartholomew's Hospital Museum. (Walsham.)

discoloured and surrounded with rings of sloughy tissue, I do not think there is any evidence to show that this persistence of the ligatures has been actually harmful.

The following points must receive careful attention when Senn's plates are used. One is their tendency to slide a little upon each other after the ligatures have been tied. This, which will prevent the openings from being exactly opposite to each other, must be met by running a continuous suture around the plates. To prevent any kinking of the bowel or drag upon the plates the jejunum may be attached to the stomach for a short distance on either side of the plates. Finally, feeding by the mouth should be carefully begun about twelve hours after the operation.

Gastro-jejunostomy by Murphy's Button.—This is the simplest of all the methods of gastro-jejunostomy. As has been the case with this most ingenious instrument after resection of the intestine, it has scored many brilliant successes, but in both cases there is reason to believe that the extreme simplicity of this method has led to its use in many cases which have not been published because unsuccessful. Dr. Murphy (*Lancet*, vol. i. 1895, p. 104) speaks of there having been twenty-seven cases with nine deaths. In four of these death occurred from exhaustion before the fourth day, and it is stated that in each the approximation was perfect. This date is too early to speak with confidence of the approximation brought about by the button. After remaining perfect for a longer time it may suddenly fail, as in the following case of my own.

A patient of Dr. Pye-Smith's, at Guy's Hospital, aged forty-five, was transferred to my care in April 1895, with carcinoma of the pylorus. When the stomach was exposed the growth was too extensive to admit of pylorotomy. It extended for $1\frac{1}{2}$ inch into the pyloric end of the stomach and sent numerous vascular processes along the lymphatics into both omenta. I united a loop high up in the

jejunum to the anterior wall of the stomach a little to the cardiac side of the centre of the anterior wall so as to be free of the growth. The only difficulty in the operation was making certain of the jejunum. Every step of the union of the viscera was rendered most easy by the button. For seven days the course was uneventful save for obstinate, fixed, gnawing pain which I attributed to the button having to make its way through a thick-walled viscus well supplied with nerves. On the seventh day the bowels acted after an enema. On the eighth this action was repeated, and a small slough was found in the stool. Shortly after symptoms pointing to perforation occurred with rapid collapse and death. It is greatly to be regretted that as the man was one of the paying hospital patients no autopsy was made.

I have already (p. 843) spoken fully of what I consider to be the dangers of the Murphy button. It is fair to this method to say that the carcinoma was here extensive, vascular and growing rapidly in a comparatively young patient. It is possible, therefore, that in spite of my precaution I may have placed it in tissues already affected by growth and thus certain to soften prematurely. I did not make use of the v. Hacker position, as preferred by Dr. Murphy, because the anterior or Wölfler method has given very good results, and because owing to the extension of the growth into the omenta I was unwilling to disturb the parts more than was absolutely needful. The button should be passed by the fourteenth or twenty-first day. M. Quénu gives the following result of a gastro-enterostomy performed by means of a button. A year after the operation the patient (who had greatly improved) began to fail and died sixteen months after the operation, jaundiced and emaciated, but without vomiting. The button was found in the stomach, having caused no symptoms. The communication between the viscera was freely open. Recurrence of the carcinoma had involved the pancreatic and bile ducts.

Dr. Murphy (*loc. supra cit.*) gives the following conclusion: (1) That gastro-jejunosomy should never be performed on an extremely cachectic patient. (2) The von Hacker position (p. 933) is preferable, though that of Wölfler may be used. The former favours the passage of the button into the intestine. Out of the cases in which the approximation has been made to the anterior wall of the stomach, the button has dropped back into this viscus in four; in none of them did it give any unpleasant results, and Dr. Murphy believes that it would have passed as soon as the stomach had contracted in size and the patient was up and about. (3) Owing to the poor reparative power of the tissues in these patients, it is well to scarify with a needle the adjacent peritonæal surfaces of stomach and intestine: this hastens the formation of adhesions. (4) A few interrupted supporting sutures between the stomach and intestine half an inch from the button may be necessary where there is any tension on the parts. (5) The patient should receive liquid nourishment as soon as the effects of the anæsthetic pass away.

It will be seen that the button has been used in the following operations for cancer of the stomach: (1) Gastro-jejunosomy; (2) Pylorotomy with gastro-duodenostomy (p. 926), the cut end of the stomach being closed and the distal end of the duodenum united by a button to the posterior wall of the stomach, a full inch from the line of suture. (3) Where the cancer involves but a small portion of the stomach in the neighbourhood of the pylorus, Dr. Murphy thinks that the operation which is most satisfactory in its ultimate results is to divide the duodenum two inches below the pylorus, close the proximal end with a Czerny-Lembert suture and join the distal end to the posterior wall of the stomach with the button.*

* No reasons are given for preferring this method to the combined operations of pylorotomy and gastro-duodenostomy (p. 923).

Gastro-jejunostomy by means of Decalcified Bone Bobbins.—

This method has been recommended by Mr. Mayo Robson (*Med. Chir. Trans.*, vol. lxxv. 419, and *Brit. Med. Journ.*, vol. i. 1893, p. 688). I have already, at p. 838, spoken of the advantages which Mr. Mayo Robson's method possesses, especially its simplicity, the fact that it leaves only a temporary foreign body in the alimentary canal, and the adaptability of this method to so many operations. From the success which the bobbin has met with elsewhere, it is probable that under two other conditions needful for a good result—viz., security against leakage, which is given by the double continuous suture, and the avoidance of after-closure by securing a continuity of mucous surfaces around the new channel—will be gained here also, and I am of opinion that in future the bobbin deserves an extended trial in gastro-jejunostomy.

Operation.—The chosen portions of the stomach and intestine are drawn well up into the wound, emptied, and held in position by forceps which act as guides to the spots to be opened. The peritoneal sac having been thoroughly shut off with sponges and iodoform gauze, two continuous sutures, one sero-serous and securing peritoneal apposition for fully one-third of an inch from the opening all round; the other, marginal and muco-mucous, when drawn tight, firmly applies the edges of the openings in the stomach and jejunum to the tube, thus preventing any extravasation. The sero-serous, on a curved needle, is first inserted, half or one third of an inch from the spot where the viscera are to be opened, first to jejunum and stomach alternately, the suture taking up peritoneum and outer muscular coat only. This suture is left long at the end where it begins, and when the extreme opposite end is reached it is not unthreaded, in order to complete the suturing after the bobbin has been inserted, and the marginal or muco-mucous suture completed. The viscera are then opened, the openings being just sufficient to admit the bobbin, but before its insertion the marginal suture which may be either of chromicised gut or of silk stained with aniline is applied from right to left, uniting the posterior margins of the two visceral openings, the suture including mucous membrane, and the suture being left long on the right and being kept threaded in the left. The bobbin is next inserted, and the marginal suture then proceeded with round the front until the tail of the suture is reached: the two ends are then tightened, tied and cut short, thus uniting the mucous surfaces round the tube. The serous suture is then proceeded with half or a third of an inch from the marginal one until the circuit is completed, when the two ends are tightened, tied and cut short. When the anastomosis is complete, the sutures cannot be seen (M. Robson).

In describing the chief methods of gastro-jejunostomy I have confined myself to the anterior method of union and to the less complicated procedures by which this union is attempted. In order to facilitate the passage of food into the intestines and to prevent the regurgitation of intestinal contents—*e.g.*, bile, pancreatic juice, and faecal fluids into the stomach—certain modifications of the anterior and simpler gastro-jejunostomy—very ingenious but necessarily complicated—have been introduced. My space will only allow me to allude to these.

Von Hacker's and Courvoisier's method of Gastro-jejunostomy (Figs. 254, 256, 257).—Here the small intestine is joined by suture to the posterior wall of the stomach. The stomach and omentum having been pushed upwards a piece of intestine high up in the jejunum is made use of as before, emptied and kept so either by clamps or by a ligature of drainage tube tied round it and tightly clamped with a pair of Spencer Wells' forceps. With a blunt instrument, an opening is torn through the transverse mesocolon at a spot where there are no vessels, the edges of this opening are then united by a few points of suture to the

hinder wall of the stomach, and then the loop of jejunum fixed by sutures in this gap to the hinder wall of the stomach also. The transverse colon with the great omentum occupy afterwards their normal position in front of the small intestine.

For this method the following **advantages** are claimed: (1) It facilitates drainage of the dilated stomach, thus tending to diminish flatulence and dys-

FIG. 254.

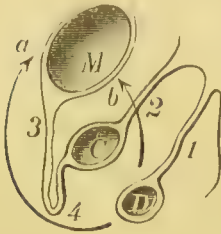


FIG. 255.

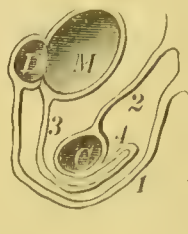
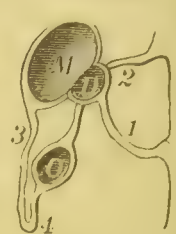


FIG. 256.



Gastro-jejunostomy shown diagrammatically.

Fig. 254. M. Stomach. C. Colon. D. Small intestine. 1. Mesentery. 2. Mesocolon. 3 and 4. Great omentum. The parts are here shown in their natural relations. The arrow *a* shows the anterior operation after the method of Wölfler, that marked *b*, the method of Von Hacher.

Fig. 255. Gastro-jejunostomy according to Wölfler.

Fig. 256. The method of Von Hacker. The numbers and letters have the same meaning as before. (von Esmarch and Kowalzig.)

pepsia; (2) It diminishes the risk of regurgitation of fluids from the intestine into the stomach; (3) This method by joining the intestine to the stomach through an opening in the transverse mesocolon,* and so below the transverse colon

FIG. 257.



Gastro-jejunostomy by the method of von Hacker. (von Esmarch and Kowalzig.)

Wölfler's and Kocher's Modifications of Gastro-jejunostomy.

—Wölfler drew attention to the fact that the long axis of the jejunum must be applied to that of the stomach in such a way as to secure the direction of the onward flow of the contents of the two viscera corresponding—*i.e.*, that the proximal portion of the stomach be to the right and the distal to the left. Not satisfied with this, he went farther, and in order to prevent any entrance of the

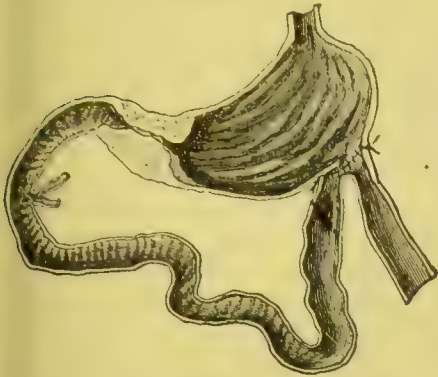
avoids the risk of strangulation of the large intestine, or at all events the occurrence of tympanites which may arise from its compression.

Disadvantages.—The two first of the above advantages are based on sound anatomical reasoning, but are, I think, secured at too great a price. V. Hacker's modification is one very easy to describe, but it is difficult to perform, and presents certain undoubted disadvantages. (1) Contraction of the opening in the transverse meso-colon may lead to obstruction of the small intestine; (2) It is much less easy in this operation to keep the different steps extra-peritoneal; (3) Secure stitching is much more difficult.

* The feebleness of the small intestine and the fact that it has been strangled in apertures in the omentum and in the foramen of Winslow must here be remembered.

contents of the intestine into the stomach, he tried to form a valve-flap over the afferent end of the knuckle of intestine (Fig. 258). Thus, while he stitched the afferent half of the opening in the intestine to the coats of the stomach, where still intact, he united the efferent half only to the edges of the opening in the stomach. The same authority maintained that the same object could be obtained in the following way (Fig. 259). The knuckle of jejunum is cut quite through, the lower end is united to the opening in the stomach, while the upper end is sutured into the intestine lower down (Fig. 259). This, if successful,

FIG. 258.



Gastro-jejunostomy by Wölfler's method.
(von Esmarch and Kowalzig.)

FIG. 259.



Gastro-jejunostomy by another method
of Wölfler's. (von Esmarch and
Kowalzig.)

will ensure the bile, pancreatic juice and other contents of the intestine being delivered into the intestine and not the stomach. But it will be seen that this is secured at great risks, by a complicated operation involving multiple and prolonged suturing, and the need of most careful adjustment of the mesentery at two points.

Kocher having noticed fatal cases occurring after successful suturing and without peritonitis, a fact only to be attributed to the absorption of intestinal

FIG. 260.

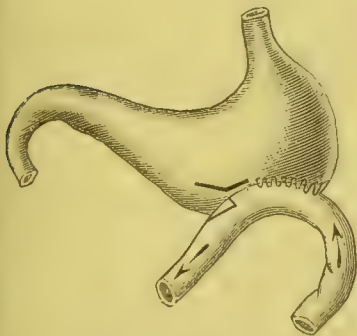
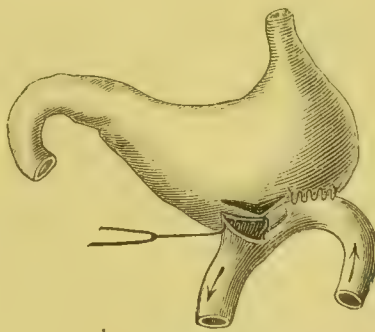


FIG. 261.



Gastro-jejunostomy by Kocher's method. The jejunum has first been so united to the stomach as to prevent kinking. The intestine should have been placed with its long axis at a right angle to that of the stomach. (von Esmarch and Kowalzig.)

contents which have reached and undergone decomposition in the stomach, unites the intestine not with the two long axes corresponding, but with that of the intestine at a right angle to that of the stomach, and in such a way that the proximal part of the loop ascends, and the distal descends. To still farther ensure that the contents of the stomach and those of the proximal part of the

stomach should pass out into the distal portion without any regurgitation. Kocher makes a valve by raising a flap from the convexity of the knuckle of the jejunum at a little distance from the stomach, a curved incision being made instead of the usual longitudinal one (Figs. 260, 261). The contiguous serous surfaces of stomach and jejunum having been first united, the outersurface of the base of the flap is next united to the lower edge of the opening in the stomach, the edge of the flap itself being left free. The upper edge of the opening in the stomach is next secured to the lower and concave edge of the opening in the jejunum (Fig. 261).

After-treatment.—It is certain that surgeons have been over-anxious before commencing to feed their patients after this operation. After careful suturing or indeed after any of the methods of gastro-jejunostomy, feeding by the mouth should be carefully begun within two hours of the operation. Such liquids as peptones, Valentine's meat juice, raw meat juice, champagne, veal tea, brandy and water, may be given in teaspoonfuls every half-hour at first and soon increased up to half-ounces every hour.

Sequelæ of Gastro-jejunostomy:—(i) **In the cases which recover.**

(1) In many great relief is given for a varying number of months from pain, vomiting, dyspepsia &c., while a gain of flesh is made and maintained. (2) In many others the relief is much more short-lived, the patient, after a short period of relief, though the appetite is voracious, makes no flesh, and quickly goes downhill again. (3) In several cases fetid vomiting has set in soon after the operation, sometimes entirely spoiling the result.

Mr. Barker's case soon began to vomit turbid fluid, which became very fetid—being apparently pancreatic secretion mixed with bile. This was checked by the use of creosote and placing the patient in the semi-recumbent position, which, allowing the intestine to slip down, caused its opening not to be exactly over that in the stomach. Mr. R. Morrison of Newcastle (*Brit. Med. Journ.*, vol. i. 1893, p. 1148) believes that this is due to the condition of the stomach. Where this fetid vomiting has followed the stomach has probably been permanently dilated and unable to empty its cavity. In those cases which recover without this complication the stomach has been probably thick-walled and not unduly enlarged. Whether this explanation is correct or not, washing out of the stomach and rendering its interior aseptic must be energetically tried.

(ii) **In cases ending fatally.**—The causes which are active here have been sufficiently indicated in the preceding pages—viz., shock, peritonitis, whether due to sepsis introduced at the time of the operation, or to leakage later on, brought about by some fault in the technique, and recurrent hæmorrhage from some of the vessels not being secured by ligature of the sutures.

DUODENOSTOMY.

This and the following operation have been proposed, in cases unsuited for pylorotomy, as a means of getting nourishment into the alimentary canal below the disease, and thus giving rest to the diseased parts. But little favour has been accorded to either of these operations and both are destined to be dropped. Duodenostomy especially has the serious objections that it deals with a fixed portion of intestine, one difficult to deal with, and one into which important fluids are poured, which thus may readily escape from a fistula made here. Furthermore, all the cases have, I believe, been fatal.

JEJUNOSTOMY.

This operation has the serious disadvantage of being liable to leakage, at a point high up in the alimentary canal, where the fluids traversing the bowel are of the greatest importance from a nutritive point of view. Thus it has followed

in the majority of cases that no great prolongation of life has followed on this operation. Dr. Hahn (*Deut. Med. Woch.*, 1894) gives a list of five cases of jejunostomy. One, a case of gastric carcinoma died in a fortnight; another, a case of œsophageal carcinoma died in four days; the third, a girl aged twenty-three, who five weeks before had drunk sulphuric acid, died on the eighth day. Mr. Jessett (*Dis. of the Stomach and Intestines*, p. 64) relates two cases operated on for œsophageal carcinoma. One survived nine months, when extension of the disease proved fatal. The other only survived seven weeks. Mr. Golding Bird brought a case before the Clinical Society (*Trans.*, vol. xix. p. 70); here the operation was performed for advanced carcinoma of the pylorus. The patient was making a good recovery up to the ninth day when fatal peritonitis occurred owing to an accident in the feeding.

Indications.—(1) Cases of carcinoma of the pylorus and stomach where other operations are impossible. (2) Cases of carcinoma of the cardiac end of the stomach and œsophagus when gastrostomy is out of the question.

Operation.—This is performed with strict aseptic precautions and in two stages. The abdomen having been opened, the jejunum is made certain of at a point high up in its course with the aid of the directions given at p. 927. A knuckle being drawn into the lower part of the wound the upper two-thirds of this are united, the bowel is fixed very carefully to the edges of the wound, very much as in gastrostomy (p. 900). The intestine should be opened on the third day by a very small puncture. Later on, when all is firm, the patient will be able to feed himself by a funnel and tubing. If it is absolutely needful to open it at once, the surgeon may try to make an oblique opening after the method of Witzel (p. 903). Mr. Golding Bird found that a meal of fifteen or twenty ounces every four hours, the catheter being directed upwards always caused symptoms due to over-distension of the small intestine, and that a better plan was to give a meal of ten ounces, half being given towards the duodenum and half towards the ileum.

CHAPTER VIII.

EXCISION* OF THE SPLEEN.

Indications.—All of these are rare, and many of them are still doubtful.

1. Cystic spleen. When this is found to be unsuited for drainage. Mr. K. Thornton's case of this kind was the first successful splenectomy in England.

2. Injury. This has been already alluded to when gunshot injuries of the abdomen were considered (p. 885). Other cases in which it may be called for are, prolapse of a spleen, injured or not, through a wound, rupture of the spleen, and stabs of this viscus. Hitherto surgeons have often been deterred from attempting to remove a ruptured spleen by the frequency with which this injury is complicated by other abdominal or thoracic organs, especially the liver itself. From the shock of these the patient never rallies sufficiently to justify exploration. Fresh interest will be called to this matter by three successful cases of splenectomy for rupture of the spleen brought by Messrs. Ballance and Pitts before the Clinical Society (*Lancet*, vol. i. 1896, p. 484). In the first case under Mr. Ballance a boy, aged ten, had been struck five days before his admission into St. Thomas's Hospital, by a "full pitched ball" on the left side. Severe pain followed, but passed off until a few hours before admission. At this time severe shock was present from which the patient rallied slightly. The spleen was removed through a four-inch incision in the left linea semilunaris.† It was noticed that a spleniculus was left behind. The boy recovered rapidly, and was in robust health five months later, but the superficial glands had enlarged. In the second case, also under Mr. Ballance, the patient, a woman, aged forty-five, had been run over by a hansom cab. Shock was so marked a feature that operation was not justified until the next day. Though the patient left the theatre in a desperate condition, in ten days she was apparently convalescent. Then she began to go down hill, and by the eighteenth day her condition was again critical, with weakness, emaciation, thirst, drowsiness, &c. The administration of extract of sheep's spleen and raw bone marrow daily restored her gradually to convalescence and ultimately to complete recovery. Some groups of external lymphatic glands could be felt in this case. In the third case, under the care of Mr. Pitts, a man, aged thirty-six, had fallen on an iron girder, striking his left side. He complained of pain there, but was otherwise apparently well. About four hours later he became suddenly collapsed. Four hours afterwards he had responded sufficiently to restoratives to make operation justifiable. This patient, like the second one, when apparently convalescent began to lose ground in a similar way. Cod liver oil and bone marrow were given, but it was not till arsenic was administered that any real improvement was observed. He ultimately

* Cases in which the spleen was incised for suppuration will be found in the *Brit. Med. Journ.*, vol. ii. 1887, p. 1047, and vol. i. 1888, p. 586.

† In one at least of these three cases the spleen appears to have been removed by a median incision. This would have the advantage of allowing the operator to investigate the state of the liver and kidneys.

gained robust health, but all the superficial lymphatic glands could be felt enlarged. In each of these cases the spleen was not only ruptured, in the third completely across, but the vessels in the hilum were torn across also. The authors remarked that where this was not present a rupture of moderate severity might perhaps be treated by suture. As to the diagnosis of ruptured spleen these brilliant successes point to the value of the following: (a) The locality of the injury; (b) the evidence of internal hæmorrhage; (c) the great increase of fixed splenic dulness; (d) the evidence of an increasing collection of fluid in the abdomen, and of the fact that while the dulness in the right flank can be made to disappear by change of position, that in the left flank remains constant. The operation should not be performed until the patient has sufficiently reacted from the stage of collapse, and it should take place before that of suppurating clots and a toxic state of the patient has supervened. In the case of the spleen where an escape of blood alone follows on the rupture, the last mentioned most grave condition will not follow so quickly as in the case of the kidney. The peritoneal sac should be cleaned as thoroughly as possible from all blood and clots. Every precaution for meeting shock (p. 814) should be taken before and after the operation. 3. Movable or wandering spleens. When this condition causes troubles, analogous to those of movable kidney, not relieved by a belt. Dr. McGraw (*Med. Rec.*, vol. xxxiii. No. 26) removed an enlarged and dislocated spleen, which formed a tumour in the right iliac fossa, and partially displaced the uterus and bladder. A week later pain in the left shoulder and left-sided pleuro-pneumonia supervened. Nine months afterwards the ligature was coughed up. Recovery followed. The remaining conditions are much more doubtful. 4. Malignant disease. Primary sarcomatous or carcinomatous disease of the spleen is extremely rare. The only case I can quote is one removed for primary sarcoma by Prof. Billroth (*Lancet*, June 7, 1884). Mr. Butlin, referring to the same case, says that it was reported shortly after that recurrence had proved fatal in a few months. 5. Hypertrophy of the spleen. The operation must here be limited to those rare cases in which simple (non-leukæmic)*—e.g., malarial—enlargement of the spleen resists other treatment. In Mr. Thornton's table, in fourteen cases of splenectomy for "Hypertrophy," four were successful, and ten fatal. 6. Leukæmia. This operation has been so invariably fatal that it ought to be abandoned.†

G. A. Wright, of Manchester (*Med. Chron.*, Dec. 1888), draws these conclusions from a study of the cases of removal of the spleen: "(1) Splenectomy for leukæmia is inadmissible. (2) Splenectomy for hypertrophy is very dangerous, the chief danger being from hæmorrhage and shock, and there being especial danger of bleeding from a vessel that passes between the spleen and the diaphragm. Whether it is altogether an abnormal vessel or merely a dilatation of a small vessel existing there, I do not know, but it is responsible for the death of my patient, and of three others, including a leukæmia patient. (3) If malarial cases require removal of the organ there is a good prospect of recovery. (4) Cases of floating spleen and of simple cyst are eminently favourable for operation. (5) From a special consideration of my own case, I should say that in a patient with simple hypertrophy or chronic splenitis, a careful examination of the relations of the organ should be made before dividing any vessel, and if

* It seems to me that this distinction has not been sufficiently made. Several of the cases operated on read like an early condition of leukæmia, and in those ending fatally the rapid onset of death after the operation is often suggestive of the ending of leukæmic splenectomy.

† Mr. Greig Smith gives 18 cases; Mr. Thornton, 13; Mr. Collier, 16—all fatal. The only case which has recovered—Franzolini's of Turin (*Wien. Med. Woch.*, 1883, No. 20)—is considered one of hypertrophy by Thornton, Collier, and Crédé.

large adhesions to the diaphragm are found, and the spleen is firmly fixed, and the pedicle broad and ill-defined, the operation had better be abandoned. It is of course, impossible to stop if once there is any laceration of the splenic tissue since the bleeding can only be arrested by removal of the organ. If removal is found to be impracticable, the question of ligature of one or more of the main vessels supplying the spleen is worth considering. Ligature of the splenic artery was suggested by Lucas but has, so far as I know, never been tried."

Operation.—The preliminary steps will be directed to ensure asepsis and to diminish shock (p. 814). The incision has usually been one in the linea alba. The advantages of this in the case of ruptured spleen have been given above. For other cases that in the linea semilunaris, or one further out (Bryant), from the left anterior superior spine to the ribs, would probably give better command over the pedicle. All hæmorrhage having been stopped, the peritonæum is opened freely and the hand explores the tumour.* Any adhesions, as of the overlying omentum, are separated, between ligatures if needful. Where the adhesions are very broad, interlocking chain-ligatures must be employed. In a very few cases the use of the thermo-cautery may be justified. Any adhesions with the pancreas are very different to deal with. Esmarch and Kowalzig advise removal of a portion of this viscus. The spleen is next brought out of the wound the lower extremity first, and either carbolised sponges or towels are carefully packed around it. This extraction of the viscus must be carried on with the utmost caution and gentleness, as its friability may easily lead to a tear and most profuse oozing, and as dragging on the pedicle may easily induce collapse and is also likely to lead to some small vessel retracting from the ligatures as they are applied, and causing fatal hæmorrhage.

The spleen being wholly outside the body, the most important part of the operation, securing the pedicle, remains. This structure, if present,† must be carefully examined. If the patient's condition is good, the safest plan will be to secure the vessels as far as possible separately, the pedicle being divided, as Mr. Greig Smith suggests, piecemeal between pressure-forceps; where there is not time for this, it will be wiser to secure the vessels in two or three portions, transfixing in two places, and locking the ligatures (Thornton). Carbolised silk should be used, fairly stout, and not tied so tightly that it will cut its way through too quickly. However the pedicle is treated, the following precautions should be followed: (1) To prevent any tension being exerted on the pedicle (*vide supra*). (2) To secure every vessel. (3) To divide these, in a relaxed condition, at a sufficient distance from the ligatures. (4) Not to include the tail of the pancreas. (5) After all the ligatures have been applied, it may be well for sake of safety to throw one round the whole. (6) Not to twist the spleen round at all in dealing with the pedicle.‡ In some cases where secondary hæmorrhage is feared, the pedicle should be kept outside. Again, when oozing from adhesions is very likely to take place, especially when a large gap is left by the removal of a huge spleen, plugging with iodoform gauze after the method of Mikulicz will be advisable (p. 819).

The abdominal sac is next cleansed and the operation completed as after ovariectomy. The after-treatment is also much the same.

* If the surgeon is satisfied that the adhesions between the spleen and the diaphragm are extensive and intimate he will do well to close his wound.

† In a case of Mr. L. Browne's (*Lancet*, vol. ii. 1877, p. 310) there was no pedicle as such, four very large arteries being met with and secured with double ligatures.

‡ Sir S. Wells (*Med. Times and Gaz.*, January 6, 1866, p. 4) draws attention to this. Having done so in order to bring the vessels into a cord, the splenic vein was ruptured.

Causes of Death.*—By far the most frequent is hæmorrhage. This may be from the omentum adherent over the spleen, from the large vessels to this viscus, from some small vessel which has retracted, from the splenic vein, or from sponge-like adhesions (Bryant). Mr. Hatch of Bombay (*Lancet*, 1889, vol. ii. p. 1053) met with a case in which death took place a few hours after the splenectomy, owing to oozing from some adhesions between the spleen and the diaphragm, which had required separation.† The pedicle was safely secured. In another case (*Centr. f. Chir.*, July 18, 1885), death, twenty-four hours after the operation, was due to bleeding from the abdominal incision, owing to the defective coagulation of leukæmic blood. The ligature on the pedicle was firm. The after-treatment of post-operative anæmia, &c., is given at p. 938.

* Adelman, to render splenectomy safer, has suggested its performance in two stages.

† See also G. A. Wright's case (*loc. supra cit.*). This surgeon suggests the use of a long, sharply curved tenaculum for stopping bleeding from a deeply seated vessel in the back of the abdomen.

CHAPTER IX.

OPERATIONS ON THE LIVER AND GALL-BLADDER.

HYDATIDS. — HEPATIC ABSCESS. — CHOLECYSTOSTOMY.—CHOLECYSTOTOMY.—CHOLELITHOTRITY.—CHOLEDOCHOTOMY.—CHOLECYSTENTEROSTOMY. — CHOLECYSTECTOMY.—TREATMENT OF BILIARY FISTULA.—REMOVAL OF GROWTHS OF THE LIVER.

OPERATIONS FOR HYDATIDS.

THIS will include different forms of puncture, free incision, and electrolysis. The milder measures of puncture and electrolysis have proved successful in many cases, but we do not know for certain how the death of the parasite is brought about by them in successful cases, and they are largely uncertain.

A. **Puncture.**—While incision is the only certain and reliable mode of cure, it is worth while to try the different forms of puncture, especially in certain cases, as when the patient refuses severer methods.

There is no need to do more than to describe briefly such an operation as this, and to tabulate the chief practical points.

The parts being cleansed, and an anæsthetic * given if the patient is very nervous, the surgeon chooses a spot for puncture at a most prominent part of the tumour, satisfying himself as to dulness.† If the skin is thick he makes a minute puncture with a scalpel and sends in a fine trocar or aspirator needle. The quantity withdrawn must vary with the case, the size of the cyst, the timidity of the patient, &c. From six to sixty ounces are instances of small and large quantities. The aspirator should, on the whole, be preferred, as likely to remove more fluid, and thus, probably, more likely to produce a cure, but as the exhaustion is more likely to plug the cannula, a fine wire must be in readiness.‡ Escape

* It is well to dispense with this, if possible, from the possibility of leakage taking place after the subsequent vomiting. As an injection of cocaine will give almost as much pain as the fine trocar, the part may be frozen with the ether spray if needful.

† If this is presenting against the right ribs, another spot should, if possible, be chosen (foot-note, p. 944). Hydatids of the liver should never be explored or attacked through the ribs, if another site is obtainable.

‡ Dr. Fagge (*Medicine*, vol. ii. p. 321) thought that the value of the aspirator must depend entirely on the position of the hydatid. If a large part of the cyst

of bile, blood, or the setting up of a cough are indications for stopping. While the cannula is withdrawn the surrounding parts should be pressed around it, and rather depressed, so as to diminish the risk of leakage as the cannula leaves the cyst. The puncture is then closed with iodoform and collodion, and a small pad of dry gauze and salicylic wool comfortably secured with a many-tailed bandage. A little morphia may be given for the first twenty-four hours. The instruments used should be sterilised, and the additional trouble entailed by irrigation with a solution of hydr. perch. will not be thrown away.

Practical Points.

1. Puncture alone is more likely to be radically curative in the following cases:—A small cyst, seen early. An acephalocyst. The more daughter-cysts, brood-capsules, and scolices are present, the less likely it is that puncture will suffice.
2. Puncture is often very useful as a means of diagnosis in those obscure cases, in which hydatids of the liver simulate disease of the pleura or lung.
3. Incision should be made use of where tapping fails, where scolices instead of fluid form the greater part of the contents of the cyst, where suppuration is present or imminent, and where chest complications are set up by the hydatid, showing perhaps a risk of perforation.
4. A few weeks after puncture secondary enlargement is often noticed. This is not undesirable as long as it subsides, which it usually will do gradually, being due to inflammation. On this account Dr. Fagge advised that no second operation on a hydatid should be performed within twelve months, unless suppuration is present.
5. Leakage after puncture may be shown by fluctuation, more or less distinct, in the flanks. The result of this seems to have been variable. In some cases it has been absolutely harmless, as in a case of electrolysis of mine mentioned below. In others it has been as certainly followed by fatal peritonitis.
6. Cases of hydatids treated by puncture should be watched for some time to make certain that the cure is a sound one.
7. The surroundings of hydatids of the liver are of truly vital importance, and sudden death has followed an operation more than once. Thus, in Mr. Bryant's case (*Clin. Soc. Trans.*, vol. xi. p. 230) while a hydatid cyst was being tapped, the portal vein, which had been pushed upwards and forwards by the projection of the cyst on the under-surface of the liver, was transfixed. Death followed in five minutes, and was thought by Dr. Fagge to be due to hydatid fluid being sucked into the vein as the trocar was withdrawn.

In a Russian case (*Lond. Med. Rec.*, 1885, p. 414) the pulse suddenly stopped while the cyst, which had been exposed by abdominal section, was being stitched to the incision. At the autopsy, a crumpled echinococcus had made its way into the right auricle, and a fragment of one into the right division of the pulmonary artery, by an opening between the thinned cyst and the inferior vena cava.*

B. Incision.—The indications for this in preference to tapping have been given above. It may be performed in one or two stages. The operation is thus performed: The parts being cleansed and the other preliminary steps taken, the surgeon makes an incision about 4 inches long over the most prominent

is outside the liver substance, the aspirator may be used with advantage; but if the cyst be almost entirely buried in the liver, Dr. Fagge thought the possible suction on a cyst surrounded by resistant tissue must involve some risk of setting up inflammation.

* Mr. Willett (*Brit. Med. Journ.*, November 13, 1886) mentioned a case in which he had to aspirate a doubtful swelling of the liver. He used an ordinary-sized needle, and within two minutes the patient was dead. It turned out to be a case of malignant disease. No large vein had been pricked, and there was no hæmorrhage. The sudden, fatal syncope seemed due to the impression made on the nervous system through the solar plexus.

part of the swelling * (previously carefully percussed) down to the peritonæum all hæmorrhage is next arrested, and the above layer carefully divided and sutured to the subcutaneous tissue in the edges of the wound with a few points of chromic gut. The liver is now recognised, and carbolised sponges or towels or, better, iodoform gauze tampons wrung out of carbolic acid lotion 1 in 20, are carefully packed in on either side so as to prevent any escape of fluid into the peritonæal sac.

The needle of an aspirator or a fine trocar is then thrust in, and the existence of fluid beneath thus verified. As the needle is withdrawn the liver is incised, and a finger quickly plugs, and then enlarges to $1\frac{1}{2}$ inch, the opening made by the knife. Hæmorrhage, if free, is easily arrested thus, or by sponge-pressure. Escape of fluids into the peritonæal sac is prevented by the use of the tampons already mentioned, by an assistant keeping the edges of the wound carefully adjusted to the liver, and, lastly, by the next step, which consists in hooking up the opening in the liver with the finger, and in stitching the edges of the wound in the liver to that in the abdomen with a continuous suture of chromic gut. In inserting this, care must be taken to unite peritonæum to peritonæum, and to take up a sufficiency of liver-tissue by inserting the needle well away from the edges of the wound. As the sutures are inserted the tampons &c. must be gradually withdrawn, and, if the fluid escapes very freely, it may be well to turn the patient over on one side. Any scolices which are within reach are next removed, and, if the cyst is firmly stitched and the patient's condition good, the contents of the hydatid may be cleared out with sponges on holders, aided by scoops. All handling must be of the gentlest. A large drainage-tube is then inserted, and the usual gauze dressings applied.

Operation by Two Stages.—An incision, four inches long, is made through the abdominal wall over the most prominent part of the swelling. All bleeding having been carefully stopped, the peritonæum is picked up and slit open. The liver, recognisable by its characteristic colour, is at once seen moving with respiration. To make certain of the position of the fluid, a fine trocar may be now thrust in, one or two carbolised sponges having been first inserted. If the cyst be crammed with scolices, very little fluid escapes; if it be an acephalocyst, the fluid may spirt out under the high pressure not unfrequently met with. After a few ounces have been withdrawn, any leaking is stopped by sponge pressure, the parietal peritonæum is stitched to the edges of the wound by a few points of chromic gut suture, the wound plugged with strips of iodoform gauze wrung out of carbolic acid (1 in 20), and the dressings firmly bandaged on with a good deal of pressure so as to keep the abdominal wall as far as possible in contact with the liver.† On the third day the operation is completed by incising the liver, now well adherent, and inserting a large draining-tube. I have operated by both methods on patients of my colleagues Dr. Pye-Smith, Dr. F. Taylor, and Dr. Newton Pitt. All the cases did well, though in two the complete filling up of the cavity was very tedious. One, a woman, three months pregnant at the time of the operation, went her full time subsequently.

* This incision should always be made in front. Even if a cyst or abscess shows its greatest point of prominence through the ribs, it should not be opened here if possible, unless it is quite certain that the pleural space is obliterated: moreover the large drainage-tube needful easily causes caries of the closely adjacent ribs.

† One case bulged out the right lower ribs most markedly. For reasons already given, I preferred to attack it in the front of the right hypochondrium. On exposing the liver, a hydrocele trocar passed through $1\frac{1}{2}$ inch of hepatic tissue before fluid was reached. Very little hæmorrhage followed the completion of the second stage of the operation.

C. **Electrolysis.**—This mode of treatment was used by Dr. Fagge and Mr. Durham in eight cases, and the results brought before the Medico-Chirurgical Society (*Trans.*, vol. liv. p. 1). The *modus operandi* here is uncertain, as in puncture, but it seems probable that neither the electrolytic action nor the leakage of fluid into the peritonæal sac, but the puncture alone of the needle, is the essential element.* This being so, and the method requiring special instruments, it has, I believe, fallen into abeyance. In one case, a patient of Dr. Moxon's, I made use of this method after previous tapping had failed. The steps taken by Dr. Fagge and Mr. Durham were carefully followed. Two electrolytic needles were passed into the most prominent part of the swelling, about two inches apart, and were then attached to wires both connected with the negative pole of a galvanic battery of ten cells. A moistened sponge connected with the positive pole was placed on the skin at a little distance. The current was passed for half an hour. The punctures were then closed with a pad of gauze. Indistinct fluctuation could be made out in the flanks during the next forty-eight hours. There was no constitutional disturbance, the tumour steadily diminished in size, and a good recovery took place. But I lost sight of the patient afterwards.

HEPATIC ABSCESS.—HEPATOTOMY.†

As tapping by a trocar, and draining the abscess by the cannula left in, or a drainage-tube passed through the cannula, the latter being then withdrawn, is unsatisfactory,‡ and as the use of the aspirator here is mainly exploratory and palliative, it is to a free incision that we must look for a permanent cure. This may be employed in three ways:

1. Direct incision and drainage, when tenderness, cedema, and redness, make it probable that adhesions exist. This needs no further comment.
2. Incision and drainage by abdominal section, in two stages.
3. Incision and drainage by abdominal section, at one sitting.

The methods of treating an hepatic abscess by abdominal section, whether in one or two stages, have already been spoken of at p. 943, under the heading of Hydatids. They have the following advantages over other modes of treatment: (a) The benefit of a free incision and thorough drainage; (b) the surgeon can see what structures he is dealing with (see the foot-note above); (c) bleeding from the liver can be seen and arrested; (d) if pus escapes into the peritonæal sac, this can be cleansed.

Very little need be said here of the treatment by abdominal section in addition to that already written at p. 943. In the two-stage method the surgeon will open the peritonæal sac, suture the parietal peritonæum to the edges of the wound, insert some gauze, and endeavour, by well-adjusted bandaging, to keep the abdominal parietes in contact with the liver, opening the abscess on or after the third day.

In the method by direct incision, a free incision of four or five inches is made

* Thus, in a case of Dr. Playfair's, related in the Appendix to Dr. Fagge's paper, progressive diminution, almost identical to that noticed after electrolysis, followed acupuncture only.

† This term is also applicable to incisions of the liver for hydatids.

‡ Thus (1) the cannula and tube may slip out. (2) The drainage is inefficient. (3) If the pus leaks into the peritonæal sac, it does so unseen. (4) The trocar may puncture important parts. Thus, in one case of Mr. K. Thornton's (*Med. Times and Gaz.*, 1883, vol. i. p. 89), the omentum, containing large veins, lay over the liver. (5) Puncture and drainage would be quite insufficient in cases where more than one abscess existed.

and the parietal peritonæum united to the subcutaneous tissues of the wound. The position of the pus having been verified by a fine trocar or aspirator needle, some soft carbolised sponges (previously counted) or tampons of iodoform gauze are carefully packed around. The abscess is then incised, and the opening at once plugged, and freely dilated with the finger. Any escape of pus into the peritonæal sac is prevented (1) by the careful sponge-packing; (2) by the finger hooking up the liver against the wound; (3) by an assistant keeping steadily the parietes against the liver. Hæmorrhage is prevented by the above forceps or sponge-pressure. When the abscess is empty,* its opening is plugged with a sponge, and the liver and the parietes being still kept accurately together, the sponges first inserted are removed,† and the edges of the liver wound stitched, with carbolised silk passed with curved needles on a holder, to the edges of the abdominal incision, care being taken to keep peritonæal surfaces well in contact. If the pus is fetid, the abscess cavity should be well irrigated with a dilute antiseptic lotion. A considerable thickness of dry gauze dressings will be needed at first, easily renewed by means of a many-tailed bandage.

TREATMENT OF HYDATIDS IN THE LIVER WHICH HAVE OPENED, OR WHICH THREATEN TO OPEN, INTO THE CHEST.—I refer here to those grave and difficult cases where a hydatid cyst or hepatic abscess, instead of making its way towards the abdominal wall, works upwards, thrusting up the base of the lung. Perhaps the first few tapplings have drawn off fluids from the front, but after this the cyst recedes from the epigastric region as in Mr. Owen's case (*loc. infra cit.*). In other and rare cases the cyst or abscess has been opened from the front or the side, through the abdomen, but insufficient drainage is thus given. In such cases the advice given in the foot-note, p. 944, must be set aside, and the fluid must be drained through the pleura.‡

Mr. Godlee sutured the diaphragmatic and costal layers of pleura round the edge of an aperture, made by removing a portion of rib, and then opened an hepatic abscess. Mr. Thornton, treating a similar affection with a view of obtaining a funnel, through the pleura, along which the pus could escape safely, first raised the parietal pleura all round, so as to get a little free edge, then made a very careful longitudinal incision through the visceral pleura, raised it all round, and then with a fine curved needle united the two layers with a continuous fine silk suture. A channel being thus made, the liver-abscess was opened by a curved trocar, the puncture converted into an incision, and a large drainage-tube inserted. Mr. Owen, in the case of a hydatid cyst which encroached upon the thorax, incised the eighth intercostal space, first behind the anterior axillary line. As soon as the costal pleura was divided, air rushed freely in with a very audible sound, and, the finger being introduced, the diaphragm was at once felt bulging up along the inner surface of the ribs, while the lung had retired beyond reach. The intercostal space, which was fairly roomy, was forcibly widened, but it was not thought necessary to excise a piece of rib. The phrenic pleura and the diaphragm were then carefully incised, and the abdominal cyst was dis-

* Mr. Greig Smith (*Abdom. Surg.*, p. 527) advises that, if the abscess does not empty itself readily, a large tube lying in carbolic lotion may be pinched at the end, and when placed at the bottom of the abscess will act as a siphon. He also draws attention to the need of exploring the abscess cavity for signs of a second abscess, and, if this be found, opening it with the finger or dressing-forceps. All manipulations now must be of the gentlest, for fear of hæmorrhage.

† If any pus or blood has escaped into the peritonæal sac this must be now cleansed (p. 816).

‡ Mr. Godlee (*Brit. Med. Journ.*, 1887, vol. ii. p. 872), Mr. K. Thornton (*ibid.* 1886, vol. ii.), and Mr. Owen (*Clin. Soc. Trans.*, vol. xxi. p. 78) have successfully adopted this course.

covered. A certain amount of its contents were withdrawn by aspiration, so as to relieve its tension, and to permit of some of the face of the sac being drawn through the diaphragm, and across the shallow pleural cavity to the skin wound, to which it was secured by four hare-lip pins. The serous surfaces thus placed in contact were found firmly adherent on the fourth day. An incision was then made into the cyst, and a drainage-tube inserted. All three patients recovered.

CHOLECYSTOSTOMY. — CHOLECYSTOTOMY. — CHOLELITHOTRITY.—CHOLEDOCHOTOMY.—CHOLECYST-ENTEROSTOMY. — CHOLECYSTECTOMY. — TREATMENT OF BILIARY FISTULA.

Several of the above operations will be spoken of together. As the **indications** for these operations are nearly always gall-stones, it will be well first to consider the different sites in which these are met with and the evidence by which they may be differentiated, it being always understood that, as several of the following conditions may coexist, the symptoms to which a group of gall-stones in one position gives rise often runs into those of another. (i) *The calculus or calculi are in the gall-bladder.* The diagnosis and treatment here will give widely different trouble according as the gall-bladder is (A) fairly normal; or (B) shrunken.* (A) *Calculi in a gall-bladder which is fairly normal.*—The symptoms here will be chiefly recurrent attacks of colic. No swelling may be present unless a calculus exists lower down, and for the same reasons there will be no jaundice. (B) *Calculi in a shrunken gall-bladder.*—This is one of the most difficult conditions to diagnose. In Mr. Jordan Lloyd's words (*Birmingham Medical Review*, 1895, p. 199): "It may be suspected where paroxysms of pain are frequently occurring and where pyrexia and local tenderness are present. There is no tumour and no jaundice." (ii) *The stone or stones are in the cystic duct.*—Here there will be colic, and presence of a swelling having the characters of a distended gall-bladder. Jaundice is as a rule absent, but if a calculus in the cystic duct makes pressure on the common hepatic duct this point of guidance will be lost. (iii) *The calculus, one or more, occupies the common duct.* This, according to the duration of the mischief, may be dilated, and the same applies to the tracts behind, unless other calculi are present here. In addition to colic, jaundice and a swelling will be present, and if adhesions are forming, if any ulceration and septic process is going on, pyrexia may be present also. Mr. Lloyd (*loc. supra cit.*) gives two more conditions, viz.: (v) The stone or stones are in the common bile duct, which with the hepatic duct is thickened and dilated, while the gall-bladder and cystic duct are shrunken and indurated; and (vi) The shrunken gall-bladder is packed with stones, and a calculus is also present in the common duct. The symptoms of the two last are much the same; viz., (1) Paroxysmal hepatic colic; (2) well-marked attacks of chills, sweating and fever; (3) chronic jaundice of varying intensity, deepening after each paroxysm, and fading during the intervals (Osler). It will be seen that the

* M. Terrier (*Le Prog. Méd.*, 1892, t. xvi. p. 473) thinks that the condition of the gall-bladder will prove of great importance in the diagnosis of obstruction due to impacted calculus in the common duct, and that due to malignant disease of the head of the pancreas. In the latter the gall-bladder will be greatly dilated, in the case of impacted calculus it will often be shrunken and matted down by adhesions. Other points which may help in deciding between these two conditions are the time the trouble has lasted, and the age and general condition of the patient.

condition present in No. i. (B), and in No. vi. can only be verified by operation.*

CHOLECYSTOSTOMY.

Much of the account of this operation refers to several others on the biliary tracts, as in practice several are employed at the same sitting. The anæsthetic will usually be the A. C. E. mixture or chloroform, ether being unsuited to many of these patients, often middle-aged and stout and flabby, and the subjects of chronic bronchitis. The abdomen having been cleansed (p. 656) and the parts relaxed, one of the following incisions is made use of: (1) A vertical one, over the prominence of any swelling present, or straight down from the tip of the cartilage of the tenth rib. It should be 4 inches long to begin with, and should be prolonged down to the level of the umbilicus if more room is wanted for the exploration of the common duct. This incision, if widely retracted, will answer in nearly all cases. Where the adhesions are very difficult to deal with, more room may be got by adding to it a transverse incision carried inwards along the margin of the ribs at its upper extremity. Another very useful incision which is always employed by some operators, and which is excellently suited for those cases where much difficulty is expected, is a transverse or curvilinear one, starting a little below the tip of the ninth rib, at the outer edge of the rectus, and passing in a transverse or curvilinear direction into the loin; if extra room is needed it may be carried as far as the inner edge of the quadratus lumborum.† Either of the above incisions will give better access than one in the linea semilunaris or linea alba. The second one gives the best access of all, but we must wait for the results of cases which have been adequately watched before we can accept as certain the statement that the transverse incision is no more likely to be followed by a ventral hernia than is the vertical one, because it is in the upper and firmer part of the abdominal wall. The

* However obscure the case, aspiration by itself is not to be practised. Any information that it might give can be more safely gained by a small exploratory incision, for the use of even a fine trocar is not unattended with danger. Thus in two cases (quoted by Mr. Greig Smith), in one of which Dr. Harley explored with a fine aspirator-needle, after a short interval the patient died with enteritis and peritonitis. In a case of Dr. Keen's not a little hæmorrhage and considerable local peritonitis followed the use of a hypodermic syringe. Furthermore, the utility of this step is doubtful, for the point of the needle may easily miss the stone.

† This incision is recommended by Mr. R. Morison of Newcastle-on-Tyne (*Ann. of Surg.*, Aug. 1895, p. 181). He gives the credit of it to Dr. John Duncan of Edinburgh. Besides the excellent access which the incision gives, there is another advantage which will be given when the subject of drainage is considered. This incision is practically the same as Courvoisier's, much used on the Continent and in America—viz., an incision about ten inches long, running obliquely parallel to the lower border of the right ribs, and about half an inch below them, with its centre lying over any swelling that is present.

peritonæum having been reached, any vessels which need it are secured with chromic gut. The peritonæum is next picked up and opened, and if the gall-bladder is not seen at once the finger is introduced, the liver edge being taken as a landmark to feel for any calculi which may act as a guide. The difficulties met with here may be due merely to omentum or distended intestines concealing the gall-bladder, or adhesions may have taken place about this structure to a varying degree.* In some cases it may be actually buried in adhesions, involving such structures as the abdominal wall, omentum, duodenum, and pylorus.† The liver

* The following case of Mr. Robson's is a good instance of the difficulties which may be met with: the tumour on being exposed "seemed to be composed of liver, gall-bladder, stomach, and omentum matted together. No fluctuation could be made out, and the tumour seemed so firm, hard, and nodulated as to give the impression of being malignant. An exploring syringe pushed deeply into the swelling simply withdrew a little blood; but on pushing the needle through the overlapping edge of the liver, in the direction of the cystic duct, pus was withdrawn. On attempting to separate the liver from what was supposed to be the gall-bladder, pus began to well up, but fortunately none of it escaped into the peritonæal cavity, as sponges had been packed round the opening. On dilating the opening sufficiently to admit the finger, gall-stones were at once felt, one of which, about the size of a small walnut, was easily removed; the second, impacted in the cystic duct, broke in removal, leaving the distal portion still within the duct; this was removed with considerable difficulty, as, on account of the matting of the parts, the finger could not be passed beyond the cystic duct to aid in its expulsion; after its removal the index finger, on being pushed into the duct as far as possible, discovered another impacted stone, which it was found impossible to remove. As the sequel showed, this was perhaps rather a happy circumstance, for, on account of the depth, the friability, and the adhesions of the gall-bladder, it was found impossible to suture it to the surface, as the stitches would not hold; hence, after the suppurating cavity had been washed out with a solution of fluosilicate of soda (gr. x—Oj) and a drainage-tube inserted, the upper and lower ends of the incision were drawn together by silk sutures so as to somewhat limit the opening. The peritonæal cavity was left freely open, two sponges being placed on each side the opening into the gall-bladder so as to absorb any discharge flowing out of it. They were at first changed every two hours, antiseptic precautions being adopted. At the end of two days they were removed, one being simply applied directly over the drainage-tube, so as to press the parietal peritonæum into contact with the visceral." The patient made a complete recovery.

† In one case of Dr. Parkes' (*Trans. Amer. Surg. Assoc.*, vol. iv. p. 299), in which there had been a two years' history of biliary colic, "the most careful and diligent search failed to find the gall-bladder, the proper location of which was plainly outlined and felt with the finger, with reference to the transverse fissure and ligament, showing the entire absence of the gall-cyst; but close to, and partly encroaching upon the transverse fissure was found an elevated, resisting tumour, the exact nature of which could not be determined, but probably containing biliary concretions." It was too near the large blood-vessels to admit of any interference with it. An autopsy revealed remains of the shrunken gall-bladder, but with no sign of bile in it. A gall-stone lay at the junction of the hepatic and common ducts. On the other hand a distended duct below may simulate a gall bladder. Thus, M. Terrier (*Rev. de Chir.*, 1893, t. xiii. p. 95) quotes a case under the care of Yversen of Copenhagen, in which the

must be pushed up and the intestines held aside with flat sponges or iodoform gauze tampons, so arranged as to shut off the general peritoneal sac. The adhesions are then most carefully separated with a fine blunt dissector (Fig. 211), a steel director, or curved scissors.* While this is being effected the operator must be prepared in some cases for an escape of pus, which has been shut in by these adhesions, outside the gall-bladder or the ducts lower down. In some cases the gall-bladder may not only be adherent, but small and shrunken as well.†

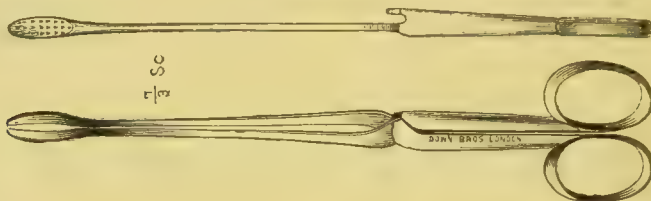
FIG. 262.



Lawson Tait's scoop for gallstones. (Down's Catalogue.)

The gall-bladder having been found, it is brought into the wound if possible,‡ sponges, counted and held in clamp-forceps, are held around and under it, and it is first emptied by aspiration; the puncture is then enlarged, and a forefinger inserted to feel for calculi. If it is clear that any present will be difficult of removal,

FIG. 263.



Anderson's forceps for the extraction of gallstones. As the blades unlock, either can be introduced separately, and then used as a probe or scoop. In a difficult case these forceps are very helpful. (Down's Catalogue.)

the edges of the opened gall-bladder should be sutured to the margins of the wound by a continuous suture of sterilised silk, or by interrupted ones at short intervals with others intervening of horsehair or salmon-gut. The parietal peritonæum must be care-

dilatation of the common duct due to a stone impacted low down was so great as to simulate a large gall-bladder. The duct was accordingly stitched to the edges of the wound, and opened as in cholecystostomy.

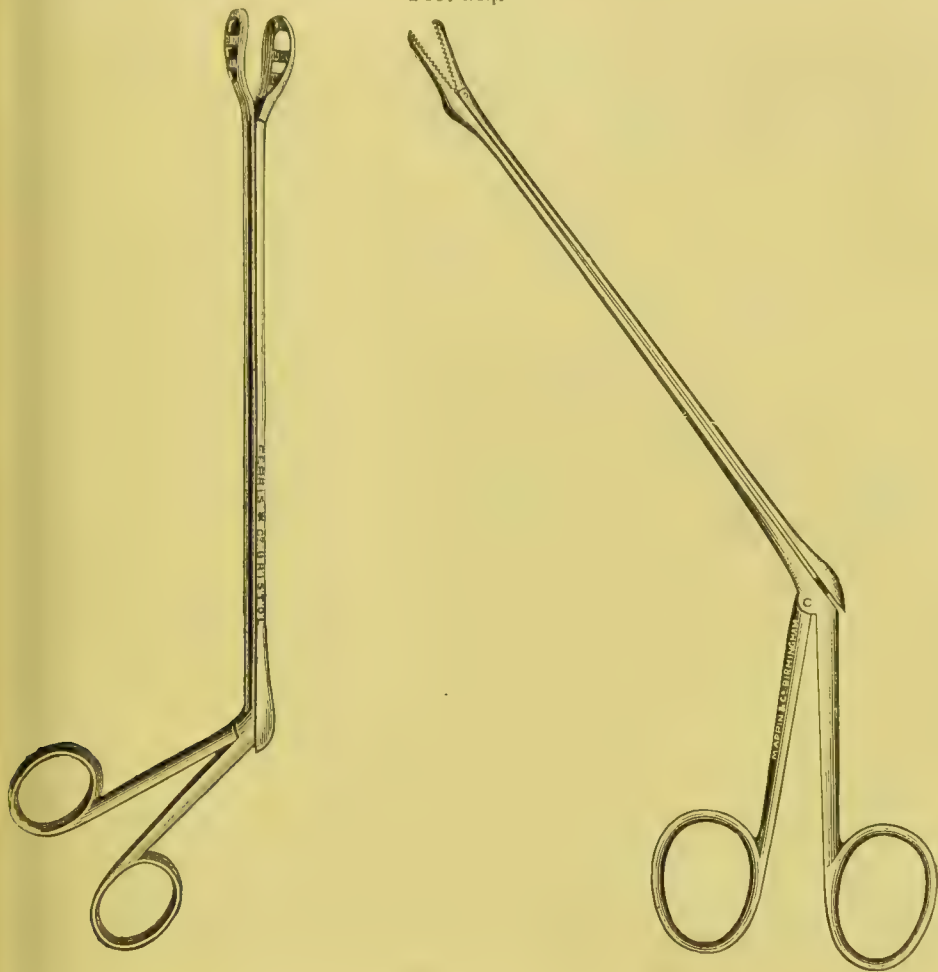
* Bleeding, chiefly troublesome oozing from adhesions, must be checked by firm sponge pressure. Spencer Wells' forceps may be safely left on for twenty-four or thirty-six hours.

† In one case of Mr. Thornton's (*Brit. Med. Journ.*, 1886, vol. ii. p. 902), the majority of the stones—412 were removed—lay in the cavity of the liver substance. Through the liver-tissue which presented in the incision stones could be felt moving on each other: the gall-bladder was small and atrophied: a large stone occupied the common duct. Here the large stone originally in the gall-bladder had become impacted in the common duct, the other stones being formed in the hepatic duct and above it in the liver, where they gradually hollowed out a cavity.

‡ Great care must be taken not to rupture a bladder much distended, or to cause sloughing.

fully taken up, and the sutures passed at a sufficient distance from the edges of the gall-bladder and the incision in the abdominal wall to ensure a good hold. The sutures should pass through any bleeding points in the cut gall-bladder, and, as the stitches are inserted, the sponges or tampons are withdrawn. Mr. Mayo Robson (*loc. infra cit.*) advises the following method of suturing the gall-bladder as likely to prevent a permanent fistula: The serous coat of the gall-bladder is sutured to the parietal peri-

FIG. 264.



Tait's cholelithotomy forceps. (Greig Smith.)

toneum, and the mucous coat to the aponeurotic layer of the abdominal wall, thus leaving the skin and subcutaneous tissue free to granulate and close the opening.

The gall-bladder having been thus safely steadied prior to any manipulations which may be needful—and the extraction of a stone fixed low down in the cystic duct is often a prolonged affair—any calculi which lie near the surface are removed with scoops (Fig. 262), dressing-forceps, or the forceps shown in Figs. 263 and 264. Of these I have found the one to the left of Fig. 264, though its blades appear somewhat clumsy, very efficient in

extracting stones when the ducts are dilated. Where a stone impacted low down in the cystic duct resists all efforts at extraction from the gall-bladder by scoops or forceps, attempts must be made to push it up into the gall-bladder by a finger introduced into the abdomen through the lower part of the wound. This, after the gall-bladder has been secured by sutures, is left open—kept plugged with iodoform gauze or a carbolised sponge—so that a finger can be introduced from time to time to assist any instrument working from the gall-bladder or to dislodge any calculus out of the cystic duct. If all attempts at removal or dislodgment fail, the calculus must be treated by cholelithotrixy, choledochotomy, or cholecysterentostomy (*vide infra*).

It will be found needful to change the dressings at first frequently after a cholecystostomy.

This operation has been performed in two stages, as in opening a hepatic abscess (p. 945), but this is quite needless here, unless the anæsthetic should be taken badly or some other quite unforeseen complication occur.

CHOLECYSTOTOMY.

Here the gall-bladder is sutured at once after the extraction of the stones, *e.g.*, with a continuous suture of the mucous membrane, and then a row of Lembert's sutures, and returned into the peritoneal sac. This step has two grave objections. (1) It is not so safe as cholecystostomy, owing to the risk of leakage, if the walls of the gall-bladder are at all inflamed and softened. This is just an instance of an operation where we hear of the successful, but never of the unsuccessful, cases. (2) It is very difficult to be certain that all the ducts are patent. If a stone be left behind suturing and returning the gall-bladder will give rise, in the immediate future, to dangerous tension on the sutures by the back-flow of the bile, while it prevents, later on, any attempts being renewed through the open gall-bladder.

CHOLELITHOTRITY.

This term has been applied to crushing up a gall-stone,* either by forceps introduced from the gall-bladder, along the inside of the duct, or applied to the outside of this through the abdominal wound. The fingers may also be used instead of forceps. We owe this method to Mr. Lawson Tait, who thus describes its employment:

"From the long, narrow, funnel-like cavity in which the stone was lodged, and from the mobility of the bladder, it was very difficult to seize, and, when at last I did get hold of it, I found it adherent to the mucous surface. I had then to consider the extreme likelihood that in removing this impacted stone I might tear the walls to which it was attached, and thus certainly kill my patient. I therefore performed a very careful and protracted lithotrixy, chipping little fragments off the stone regularly all over its exposed surface, till I had the satisfac-

* Kehr (*loc. infr. cit.*) criticises this method as risking incomplete removal of the detritus. Careful watching of these cases in addition to their immediate publication as successes, is needed before we can tell how far this criticism is just.

tion of lifting out its nucleus. I then passed the blade of a fine pair of forceps on each side of it, and by a gentle squeeze broke up the remainder."

Frequent washings out were then employed. While forceps are thus used, one forefinger is placed over the stone to guard the parts from undue violence, and to dislodge any fragments.

In another case of a stone which he could neither extract with forceps nor dislodge, the same surgeon ingeniously crushed the stone *in situ* with carefully padded forceps applied outside the duct walls, and then dislodged the fragments by finger-pressure.*

In a similar case the advice of Mr. K. Thornton may be followed—viz., breaking up the stone by means of a needle passed through the walls of the duct, the fragments being either allowed to find their way inwards into the duodenum, or being pushed by the finger up into the opened gall-bladder. Cholelithotrity has lately been largely replaced by incision of the ducts or choledochotomy.

CHOLEDOCHOTOMY.†

This term has been given to the operation of removing stones from the biliary ducts by direct incision. This method has gained ground very much of late years. Its safety in careful and competent hands has been established, and it has been proved that stones impacted deep in the cystic or in the common duct, which otherwise must have been left behind as persistent sources of misery or as causes of an open biliary fistula, extraction by opening the gall-bladder or cholelithotrity having proved impossible, can now be safely removed.

While the important relations of these ducts—especially the common—must always be remembered, the presence of the stone itself forms a reliable guide, as long as the incision is made directly over it.

We will take the operation for removal of a calculus from the common duct.‡ The incision§ in the abdominal wall being free

* In case the stone is a soft one it will be worth while to try first pressure with the finger and thumb.

† This operation was first performed by Kummell (*Deut. Med. Woch.*, 1890, No. 19, p. 237), a stone being removed from the common duct. Mr. K. Thornton reports two cases, Jan. 1891, April 4. Other very interesting papers are those by Voight (*Deut. Med. Woch.*, 1894, No. 34); Korte (*Sam. Klin. Vortr.*, 1892, No. 46); Kehr (*Arch. f. Klin. Chir.*, Bd. xlviii. 1894, S. 619); Richardson (*Boston Med. and Surg. Journ.*, vol. cxxvi. p. 409); Abbe (*N. Y. Acad. of Med.*, vol. x. p. 218; Dr. J. W. Elliot of Boston (*Ann. of Surg.*, July 1895), and J. F. Binnie of Kansas City, *ibid.* Nov. 1894; Dr. McGraw of Detroit, *ibid.* Aug. 1895.

‡ Dr. J. W. Elliot (*loc. supra cit.*) advises the following position as helpful: "The patient is hung by straps under the arms on an inclined plane at an angle of something less than forty-five degrees. A sand-bag is placed under the back, so that the patient is bent over it. In this position the intestines gravitate to the lower part of the abdomen, so that when the liver is held up by a retractor the air rushes in between the liver and intestines much as it enters the pelvis in the Trendelenberg position." Dr. R. Richardson of Boston two years before had recommended the reversed Trendelenberg position (*Ann. of Surg.*, vol. ii. 1893, p. 300).

§ If the ordinary vertical incision (p. 948) is found to be insufficient, it may

enough (p. 948) to give satisfactory exposure of the parts concerned, the liver is held up, the edges of the wound are held widely open, and the position of the stone accurately defined. The area of operation is then carefully shut off by iodoform gauze packing and sponges secured to forceps, and any adhesions over the stone are very carefully separated while the duodenum is drawn down or turned aside. The stone, firmly held, is raised as high as possible. The incision is not to be made until the surgeon feels certain that he is directly over the stone. Dr. Elliot (*loc. supra cit.*) gives the hint that when the stone is removed the fingers should squeeze the duct above while the sutures are inserted and tightened; that at this time a sound should be passed down the duct to make sure of its patency; and that the sutures should be inserted before the stone is removed, for the instant this is done the duct collapses, the wound is bathed in bile and cannot again be brought into an accessible position. The escape of bile, which is very profuse if it has been long pent up or if the blocked duct is dilated, must be met by assiduous sponging or washing away with boiled water.

The stone having been found and removed, it remains to consider the different means of treating the opening in the duct. If the passages above and below are patent, if the opening is accessible, and if the patient's condition admits of further prolonging of the operation, sutures should certainly be employed for the additional security which they give.* The escape of bile being prevented by the pressure of the fingers above the opening, the incision by which the stone has been extracted is closed by a continuous suture of chromic gut for the duct itself, while a second set of sutures of silk are used to draw together the cut edges of the overlying peritonæum. The sutures are best inserted by a small fully-curved needle held in pressure-forceps, or, as recommended by Mr. M. Robson, by a rectangular cleft-palate needle. The value of a free incision (p. 948), opening up the wound in every direction, pulling up the liver, drawing down the duodenum and colon, and, perhaps, the use of an electric lamp, will be very apparent now. The assistants must be assiduous with well-applied sponge-pressure. In the words of Dr. Binnie, of Kansas City (*Ann. of Surg.*, Nov. 1894, p. 563):

"A difficulty which occasionally confronts the surgeon is to distinguish at the bottom of a deep and narrow pit the wounded duct from oozing adhesions recently divided."

Where the opening cannot be sutured, the surgeon will use either some of the adjacent soft parts to act as a dam between the duct and surface, and so prevent the bile from entering the peritonæal sac, or he will employ drainage and iodoform gauze. Amongst the soft parts that are handy, the omentum at once

be prolonged along the margin of the ribs towards the middle line, a flap being then turned inwards.

* Even if the sutures do not hold, they do good by preventing or lessening the escape of bile while adhesions are forming to shut off the peritonæal sac.

presents itself as the most available. Mr. Mitchell Banks (*Liverpool Med. Chir. Journ.*, 1893, p. 307) in a case of cholecystostomy, in which the incision in the gall-bladder could not be united to that in the abdominal wall, made use of "the round ligament of the liver and some neighbouring omentum, which he fastened to the gall-bladder and succeeded in so banking it up as to prevent the bile from flowing into the peritonæal cavity." Binnie of Kansas City (*loc. supra cit.*) made use of separated adhesions, after extracting a calculus through the opened cystic duct.

"Suture of the wounds in the bladder and the duct might have been possible, but as it would certainly have taken much time I decided to drain, but at the same time to build up, of omentum, mesentery and existing adhesions, a diaphragm between the track of the drain and the general peritonæal cavity. Thus the wounded biliary passages were left open, a few stitches of catgut, judiciously placed, bound together the various structures above mentioned in such a way that in a few hours they became an impervious rampart of adhesions. . . . A rubber drain was also passed to the bottom of the wound, and surrounded throughout its whole length with a liberal supply of iodoform gauze."

Drainage.—It will be safer to always use this in some form or other* whenever the ducts have been incised, but with more elaborate precautions, of course, when no sutures have been inserted. To take the latter case first. A curved glass tube,† with the end turned upwards, should always be inserted if possible into the opening in the duct—an easy matter when these are much dilated. It should then be carefully packed around in its whole length with iodoform gauze.‡ The readiness with which this forms adhesions, leading to bleeding and difficulty in detaching it, is well known to those who have used it in abdominal surgery.

Dr. R. Abbe, of New York, recommends the method of drainage shown in Fig. 265, which he has used successfully (*loc. supra cit.*). A stone having been removed from the common duct, a large drainage-tube was passed into the hepatic duct through the opening in the common duct, this opening being then sewn up with fine silk. Around the tube which emptied the hepatic duct a larger one§ was placed, reaching to the common junction, and a light iodoform tampon was finally pushed in. All the bile came

* It has been stated that drainage is not needed as pure bile does not excite peritonitis. I am of opinion that the surgeon can rarely tell for certain whether the bile is pure or not. Certainly in cases where there have been repeated attacks of cholelithiasis with pyrexia it is extremely probable that the bile is infected from the intestines—*e.g.*, with the *bacillus coli communis*. And this is the more likely when any part of the ducts has been long dilated into a large sac.

† If the flow of bile is profuse syphonage (p. 977) may be adopted, rubber tubing being attached to the glass tube.

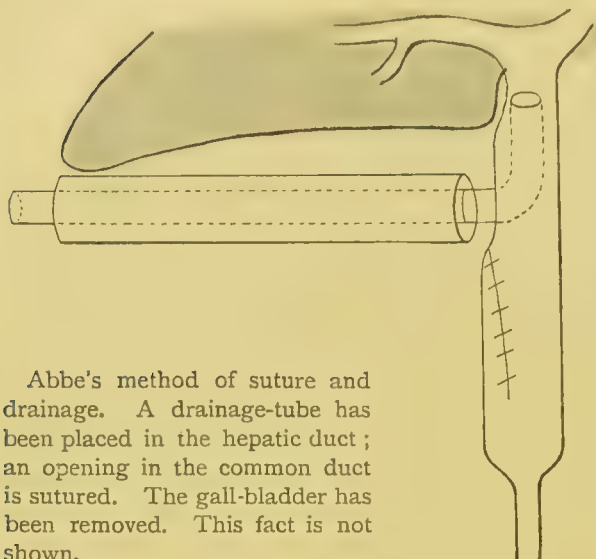
‡ This, according to the amount employed and the number of renewals required, may take from one to two weeks before it is dispensed with.

§ If glass tubes are used care must be taken that the end is not jammed against the structures with which it is in contact, otherwise ulceration may easily follow.

through the tube for five days; the inner one was removed on the second day, and the sinus closed in three weeks, the patient making an excellent recovery.

Where the opening has been closed with sutures it will still be wise to use a drainage-tube for a day or two, the indication for this being clearer in cases where the suturing has been attended with difficulty, where the edges of the duct are much bruised, and where any contraction may exist in the biliary passage below.

FIG. 265.



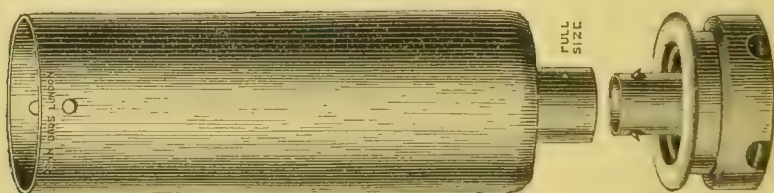
Abbe's method of suture and drainage. A drainage-tube has been placed in the hepatic duct; an opening in the common duct is sutured. The gall-bladder has been removed. This fact is not shown.

If any bile has escaped into the peritonæal sac—a rare contingency if the gauze packing has been careful—there are two places where it may be well to insert a drainage-tube. One, if the flow has been free, is in Douglas' pouch by an incision above the pubes; it will be well to keep this tube sucked out for a few hours. The other spot is one to which Mr. Morison of Newcastle

has drawn attention (*Brit. Med. Journ.*, vol. ii. 1894, p. 968). He there shows that in the right hypochondrium, between the liver and the colon, is a natural space with barriers which separate it, more or less completely, from the general sac. Mr. Morison thinks that bile may be allowed to escape into this space, as long as it is efficiently drained by an incision made through the posterior parietes immediately below the lower end of the right kidney. If the curved incision which Mr. Morison and others recommend (p. 948) be made use of, the drainage-tube will be in the lower and outer angle of the wound.

Murphy's Drainage-tube Button (Fig. 266).—This is a modification of the inventor's well-known anastomosis button in which the female half is elongated

FIG. 266.



(Down's Catalogue.)

to form a drainage-tube, so as to reach from the deep seated gall-bladder to the surface. The following is the way in which it is used: "The gall-bladder is located, a sufficient surface of its wall exposed, the contents aspirated, the purse-

string suture (Fig. 227, p. 874) inserted, the gall-bladder is incised, the small half of button inserted, purse-string tied and cut short, the tubular portion of the button is then pressed into position, the tube is then drawn out as far as the gall-bladder will permit, and held there with a pin passed through the opening in its side. During the time that the pressure atrophy in the portion of the gall-bladder clasped between the button is taking place a cicatricial wall is being formed about the tube which acts as the wall of a sinus after its production, and insures continued protection of the peritonæal cavity."

The following criticism is by an American surgeon, Dr. Binnie (*loc. supra cit.*) : "This operation is extremely ingenious, but in many cases, especially those in which its use would otherwise help us most, it is inapplicable. If the gall-bladder is deeply seated, and its walls friable, the introduction of the purse-string suture would be difficult or impossible. If the gall-bladder is very small and shrunken, it cannot contain the male half of the button. If the opening is in the duct, the button operation is generally out of the question. For these reasons the Murphy operation must be of very limited utility."

Before leaving the subject of extraction of stone, from the biliary passage, it remains to refer to one lodged so far down in the common duct as to be practically immediately outside the duodenum. As might be expected, such stones are very difficult to identify. The peritonæal sac having been opened, any omentum adherent to the abdominal wall or the neighbourhood of the liver must be separated, other adhesions carefully divided, the gall-bladder identified, if possible, as a guide. The pylorus, duodenum, and transverse colon, must also be identified and drawn to the left downwards. The liver must be kept well up out of the way with retractors or the fingers of an assistant. The identification of the common duct will now vary in difficulty according as its relations are natural or matted by adhesions. If the former is the case, the stone being exactly taken as a guide, a vertical incision is made through any fold of peritonæum passing down to or in front of the mesocolon, including the mesocolon. The vertical incision is deepened with a blunt dissector or the finger until the head of the pancreas is exposed and the deeper surface of the duodenum, including the whole length of the common duct. This will be facilitated by pulling the duodenum well over to the middle line. The importance of working most carefully just over the stone is shown by the relations of the common duct. "This receiving the cystic and hepatic ducts about two inches below the liver in the beginning of its course lies directly in front of the portal vein. Below, before it enters the duodenum, it crosses the inferior vena cava. Its orifice admits the passage of a probe or director pretty easily." (Richardson.)

Another proof of the importance of the relations of the common duct, is shown by the fact that even in Mr. Mayo Robson's experienced hands, fecal extravasation took place from a small perforation in the colon, caused by separating adhesions during the removal of a stone from the common duct, the injury being unrecognised at the time.* Another instructive case is that of Ross (*Canadian*

* *Brit. Med. Journ.*, vol. i. 1894, p. 903. A table is there given of 78 cases of operations on the gall-bladder and bile-ducts. Only four died from the operation, and in three of these malignant disease was present.

Practitioner, April 1894). Here several stones were lodged in the common duct, The duodenum was accidentally torn, and this opening was enlarged in the hope of reaching the stones through the opening in the duct, but this point could not be found. The common duct was accordingly opened and the stones removed. The duct was sutured, but owing to the friability of the tissues at the site of the roughened stone, it was impossible to prevent the leakage of bile. Drainage was employed with iodoform gauze. The bile continued to flow, but increased suddenly after vomiting, and the case ended fatally fifty-six hours after the operation.

The site of the stone having been reached with certainty,* the following methods are open to the surgeon: (1) Pushing it into the intestine, or upwards into a more accessible position. If this fail, a trial may be made of breaking up the stone either with the finger or thumb, or with padded forceps (p. 953). (2) The duct may be incised either directly, if it can be detached from the pancreas, or through the tissue of this viscus. Dr. T. A. McGraw of Detroit adopted this latter plan successfully, having first made certain of the stone by a puncture with an exploring needle. This most capable operator is inclined to think that an incision into the duct through the pancreas is preferable to one through the duct wall only, as the surgeon is thereby enabled to apply two or three tiers of sutures.† (3) The stone may be removed through an incision in the duodenum, a course successfully adopted by Dr. McBurney of New York, or a finger introduced through the incision in the bowel may dislodge the stone and enable it to be pushed upwards into a more accessible point in the common duct where choledochotomy may be performed. The opening in the intestine is subsequently sutured (p. 826). This plan is only to be followed when it is certain that the stone is impacted in the duodenal orifice of the duct. (4) Cholecystenterostomy may be employed (*q. v.*)

CHOLECYSTENTEROSTOMY.

In this operation a communication is made between the gall bladder and the small or large intestine.‡ It has received great impetus lately owing to the recommendations which it has received from Dr. Murphy of Chicago, the facility with which it can be performed with his most ingenious and expeditious button, and the good results which the published cases show. The chief **indications** for the operation are: (1) Irremediable obstruction of the common duct, due to calculus or cicatricial contraction. The second cause is

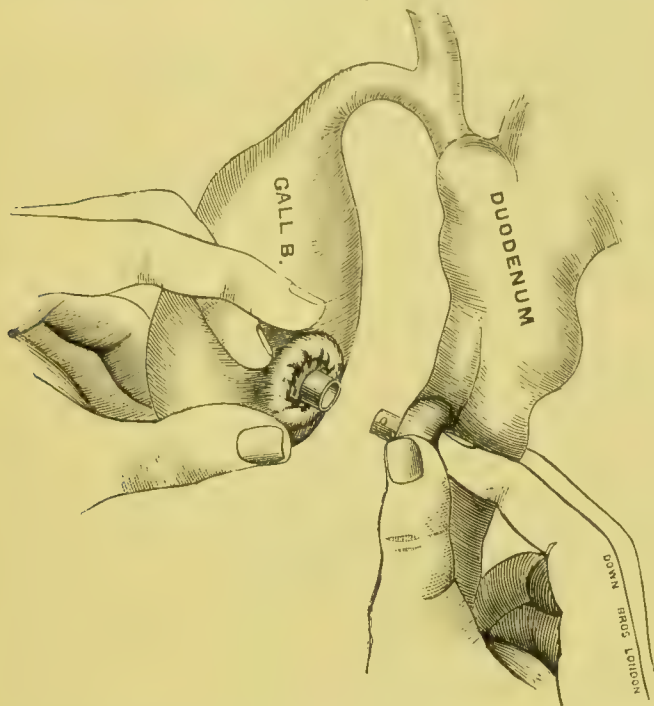
* A stone, impacted in the duct, low down, may give a hard or nodular feel which may suggest malignant disease of the head of the pancreas: an exploring needle will clear up the case.

† It is noteworthy that in Dr. McGraw's case, the jaundice and the itching were both intensified for the two days which followed the operation. This was attributed to obstruction from a blood clot or due to swelling of the incised tissues. It is just possible that it may have been due to over-complete suturing. If the duct is not dilated there must always be a risk of closing its lumen for a time.

‡ Whenever feasible the duodenum or upper jejunum should be preferred. When the small intestine is too matted by adhesions to come up sufficiently, the hepatic flexure of the colon should be chosen.

very rare and it is probable that as time goes on and surgery proves what can be done for calculi impacted here, this indication will very rarely arise. (2) Dr. Murphy (*Chicago Clin. Rev.*, Feb. 1895) also gives obstruction of the cystic duct, where cholecystostomy is impracticable. (3) A persistent fistulous opening after operations on the gall-bladder giving rise to a constant escape of bile, causing constant excoriation and annoyance, owing to the eczematous rawness. In such cases the operation of cholecystenterostomy was recommended ten years ago in this country by Mr. Willett (*Brit. Med. Journ.*, vol. ii. 1886, p. 903).

FIG. 267.



Cholecystenterostomy with Murphy's button. (Down's Pamphlet.)

Mr. Mayo Robson was the first in this country to publish a case in which the operation had been performed (*Med. Chir. Trans.*, vol. lxxiii. p. 61).

The case was one in which a biliary fistula persisted for fifteen months after "the gall-bladder had been opened for empyema." The condition of the patient was a very miserable one, as no apparatus could be made to fit sufficiently accurately to catch the bile, save when the patient was in bed. The abdomen being opened through the old scar, in the centre of which was the fistula, the gall-bladder, "much thickened and contracted, was detached from the parietes. There was so much matting of the viscera that it was found impracticable to bring up and fix the duodenum and jejunum to the gall-bladder; hence the hepatic flexure of the colon, lying near, was raised and encircled by an elastic ligature,* after its contents had been squeezed upwards and downwards. Convenient spots having been selected on the gall-bladder and colon, a circle the size of a florin was marked by a scalpel on each. Along these lines sutures of fine chromicised gut were passed, about $\frac{1}{8}$ inch apart, but these were not tightened until openings $\frac{1}{8}$ inch in diameter had been made in the centre of the

* This ligature consisted of a piece of drainage-tube, fixed by pressure-forceps. This prevented any escape of gas or faecal matter, and rendered the intestine almost bloodless, simplifying the operation considerably, hence Mr. Robson would prefer it to any other intestinal clamp.

circles, quite through all the coats of the viscera concerned, and the cut edges of the mucous membrane of the colon had been sutured by interrupted sutures of fine catgut to the edge of the mucous membrane of the gall-bladder." The refreshed edges of the old fistula in the gall-bladder were then brought together by a continuous catgut suture, the serous surface being tucked in, and a number of Lembert's sutures being further applied over the line of union. The elastic ligature was removed from the bowel, and the circulation became immediately re-established. Packing in of sponges prevented any soiling of the peritonæum. A glass drainage-tube brought out at the lower end of the wound guarded against any accident from the sutures giving way. Lastly, the parietal incision was closed. Some bile escaped about twenty-four hours after, then bile and fæces, and finally bile alone. In two months the fistula was soundly closed.

(3) Another indication which has been sometimes given is malignant disease about the head of the pancreas occluding the common duct and giving rise to jaundice, itching, &c. In such cases cholecystenterostomy must involve greatly increased risk. Hæmorrhage and imperfect repair are the chief dangers, the first especially so, as will be seen from the case given below of Dr. F. J. Shepherd of Montreal (p. 961). Dr. Murphy himself (*Chicago Clin. Rev.*, Feb. 1895) considers the operation here very unsatisfactory, there having been seven deaths out of the eight cases. Two died from shock, one from a twisting of the small intestine, before the approximation was made, a volvulus being thus produced. In another case the gall-bladder was so friable that it tore like wet paper when the sutures were inserted, and after the button was in position and the abdomen closed, the friable wall gave way and peritonitis followed. Dr. Murphy, accordingly advised that if the operation be made use of in case of obstruction due to malignant disease, it should only be in the early stage.

The indications for cholecystenterostomy having been given the means of performing the operation will next be considered. There are: (1) Suture alone as in Mr. M. Robson's case (p. 959); (2) Suture, aided by one of the bobbins now coming into use, so as to give support to the sutures and facilitate their insertion. Of these, Mr. Robson's is, I believe, the only one which has been used as yet. Two cases are very briefly given (*Brit. Med. Journ.*, vol. i. 1894, p. 902). In one of them when the dilated cystic duct had been united to the colon, the jaundice recurred a few months later. (3) Murphy's button. Cholecystenterostomy by this method requires careful attention. The attractiveness which the simplicity of this most ingenious device must always carry with it, the success* which it has met with in skilful hands, make it very probable that in the zeal of securing an immediate success, this operation may be performed, if it had not already been so, much too often. Thus to take both sides of the question, on the one hand we have these *advantages*: the two viscera which are to be united are often readily reached by a comparatively small incision. The button is very quickly adjusted, the bile soon passes by the new channel, the jaundice and itching are lost and the fæces again become natural. On the other hand the following *objections* present themselves to every candid and well-informed thinker. (1) It is clear from the account of several of the cases that the cause of all the trouble might have been removed, and not only relieved. Thus, in several stones were not removed from the gall-bladder, and the ducts were not even examined.†

* Dr. Murphy, in a report published Feb. 9, 1895, gives thirty-six cases of cholecystenterostomy for non-malignant obstructive jaundice, with only one death.

† Dr. McGraw of Detroit, and Dr. Elliot of Boston, both bring a further objection against the button consequent on this, that it often leaves behind it in the form of a stone or stones, sources of irritation, which may develop later into conditions of danger. Time must show, with careful watching and accurate reporting of cases, how far this criticism is justified.

Yet these cases are published as successes. As this operation, rendered so simple by Murphy's button, is likely to be resorted to in cases of stone impacted in the three bile ducts, it is right to point out that modern methods and recent experience have rendered removal of stones by incision so safe in skilled hands that this step, choledochotomy, is always to be preferred, when possible, to cholecystenterostomy. In other words, those of Dr. McGraw (*Ann. of Surg.*, August 1895, p. 169) "we should try not only to relieve, but also to cure." (2) Another objection, though, I believe, only proved by one case as yet, is that of septic infection of the ducts and liver from the intestine. We must remember how very different are the conditions after cholecystenterostomy, to those in health, as regards a communication between the intestine and the biliary passages. That a patient after this operation, as long as the opening remains free, must be menaced with the danger of microbe infection is proved by a case reported by Ricard (*Bull. Soc. Chir.*, t. xx. 1894, p. 572). Here death occurred fifty-three days after cholecystenterostomy, although the patient did well at first. The autopsy showed that death was due to infection of the biliary passages from the intestine, numerous abscesses due to ascending infection being present. (3) There is the risk of contraction. Unless the opening is made very free, this may set in after any method. Its liability to follow after Murphy's button has been alluded to at p. 843. (4) Hæmorrhage.* This risk must be present, however cholecystenterostomy is performed, in cases of obstruction from malignant disease, owing to the tendency to hæmorrhage in these cases; it is especially likely to follow the use of Murphy's button, whenever a thickened condition or friability of the tissues prevents the button taking that grip which is so essential for success. All surgeons owe much to Dr. F. C. Shepherd of Montreal for the candid way in which he has drawn their attention to this fact (*Ann. of Surg.*, May 1893, p. 581). His patient, aged thirty-six, had a biliary fistula resulting from a previous cholecystostomy for jaundice, pain, &c., performed four months previously, when no stone was found. Owing to the annoyance of the continual discharge of bile, the abdomen was opened again by an incision internal to the old fistula, and a mass of malignant disease was now found involving the pancreas and duodenum. It was decided to unite the gall-bladder with the colon instead of the duodenum, "as being easier and more rapid, and quite as beneficial." The button was introduced without very much difficulty, the purse-string suture being first inserted. Owing to the thickness,† of the gall-bladder there was some puckering, and the parts did not come together without considerable pressure on the button. On dropping back the bowel and gall-bladder with the button, there was no tension, and the parts seemed to be in accurate apposition, and to lie comfortably. It was decided not to close the fistulous opening, as it was felt that this would close of itself. On the morning of the fourth day, (the patient having gone on well in the interval), blood was found to be oozing from the gall-bladder and the abdominal wound. In spite of gauze-packing this continued, and the patient passed into a state of collapse. On opening the abdominal wound it was seen that the hæmorrhage came entirely from the gall-bladder. The button had cut

* Twelve years ago Dr. Musser and Dr. Keen (*Amer. Journ. Med. Sci.*, October 1884) stated that where long-continued jaundice has disorganised the blood there is a marked hæmorrhagic tendency. In one of Mr. Robson's cases (*loc. supra cit.*), where the distension of the gall-bladder was caused by cancer of the head of the pancreas, death, on the eighth day, was due to constant oozing of blood from the interior of the gall-bladder and the suture-punctures.

† It will be noticed that no mention is made of the gall-bladder being friable, the condition which was found, a little later, to have contributed so largely to the fatal result.

through the thick and friable walls, and could be easily seen. To remove the button it was necessary to incise both gall-bladder and bowel and unscrew the button. It being useless to re-insert the button, it was decided to sew up the openings in the gall-bladder and colon. A fresh oozing took place about twenty-four hours later and the patient sank.* A partial autopsy showed that the obstruction of the common duct was due to malignant disease of the head of the pancreas. (4) The button may not be passed. This happened in a case of Dr. Briddon's (*Trs. New York Surg. Soc.*, 1896). Here the bladder was dilated with non-contractile walls. The button probably fell into this viscus as the larger chamber, and there remained two months later, without causing inconvenience. Two other objections are brought against cholecystenterostomy by Dr. McGraw. (5) It produces adhesions between previously detached organs, adhesions which may interfere with their movements and with their actions. (6) After this operation the bile is diverted through the cystic duct and gall-bladder into the bowel. The gall bladder takes on itself the function of the common duct, and the common duct, remaining patulous at its upper end, receives a certain amount of bile which stagnates under conditions which favour its crystallisation, especially if, as is often the case, the common duct already contains stones.†

CHOLECYSTECTOMY.

This operation, first performed by Langenbuch in 1882, has been strongly recommended by him and other surgeons on these grounds: (1) That as gall-stones are formed in the gall-bladder, the removal of this structure will bring about a radical cure. As the nuclei certainly may form in the liver itself or in the ducts, the above opinion is not trustworthy. (2) Cholecystotomy is often followed by a troublesome fistula. This is only the case when some obstruction persists in the ducts below; under these circumstances removal of the gall-bladder is a very dangerous operation, as regurgitation of the bile, pressure on the sutures, and leakage into the peritonæal sac will certainly follow. (3) The operation is said to be simpler and no more dangerous than that of cholecystectomy. The latter of these statements is not borne out by statistics. Thiriar gives the mortality as ten per cent, and Langenbuch had two deaths out of his thirteen cases. (4) The gall-bladder is not indispensable to life and may well be spared. In answer to this Mr. Mayo Robson well remarks, "On Gall-stones" (p. 149), "It is no argument that because we do not quite know the function of an organ, the individual would be as well without it."

This operation, like that of cholecystenterostomy, appears to have been performed with needless frequency. The **indications** are very few. It must be clearly understood that to render this operation safe there must be no obstruction

* Küster (*Verhandlungen d. Deutsch. Gesellschaft. f. Chir.*, April 1861), reports a case in which two stones had been removed by incision of the dilated common duct, the opening being closed by a double row of sutures. Gauze-drainage was employed. Eleven days after the operation, hæmorrhage took place from the drain-tract, this was arrested by the thermo-cautery, and fresh packing with iodoform gauze. The patient recovered, and a year later passed two stones.

† "Here then we have the beginning of a morbid condition of which no man can foresee the end. There is no reason why in the course of time the obstructed duct may not become full to overflow with numberless gall-stones which could not fail in this receptacle to cause fully as much disturbance as in the gall-bladder itself." Only careful watching of cases can prove whether the above criticisms are true. Those surgeons who are familiar with Dr. McGraw's work will feel with me that they cannot be lightly passed over.

to the flow of bile below, a point which it is manifestly impossible to make certain of in all cases. (1) A very contracted and deep-lying gall-bladder which has been opened for the removal of stones, &c. (2) Where the walls of the gall-bladder are so thin, friable or inflamed that sutures will not hold. Under either of these circumstances, if the common duct is patent, the gall-bladder may be removed, but the experience of recent years has shown that drainage with packing of iodoform gauze will be efficient. (3) Where a mucous fistula persists, or where, as soon as the fistula closes, pain occurs, due to the accumulation of mucus in the gall-bladder, there being a complete atresia or obstruction of the cystic duct, and a free passage for the bile along the common duct. In such cases cholecystectomy offers the only chance of cure," (Mayo Robson, *loc. supra cit.*). (4) In those very rare cases where malignant disease of the gall-bladder is met with in quite an early stage.*

Operation.—Sufficient room having been provided by a free longitudinal incision prolonged laterally along the costal margin towards the middle line, or by a free transverse or semilunar incision (p. 948), the contents of the peritoneal sac are shut off with flat sponges or tampons of iodoform gauze before the adhesions of the gall-bladder are separated. These will vary greatly. In a normal case they will be simple, and all that is needful is to divide the reflexion of peritonæum which passes from the liver over the gall-bladder, and then to shell out the latter from its fossa by gently tearing through the connective tissue and vessels which hold it in place, with the finger or a pair of curved scissors, these being used as a blunt dissector as well as to cut with. In cases on the other hand, where there is much matting of the parts, the omentum, duodenum, colon, pylorus may all require most careful detachment, bit by bit, before the gall-bladder is reached, lying far from the surface, puckered and shrunken. And when this is effected, repeated attacks of inflammation may have converted its immediate surroundings into a compartment of sclerosed fibro-fatty tissue out of which it has to be shelled like a kidney, the site of long-standing calculous pyelitis, from out of its thickened, matted capsule. Friability of the walls of the gall-bladder, these tearing away on the slightest traction, is another difficulty which may be very present with a deep lying viscus. The gall-bladder having been separated as far back as the cystic duct, the first part of this is isolated, and its distal extremity tied with sufficiently stout sterilised silk. Two ligatures should be tied and an aneurism-needle may be useful here. Care must be taken not to include the hepatic, and still more the common duct, in cases where the depth of the wound and adhesions may make the relations of parts uncertain. Before severing the duct it will be well, if two ligatures have not been passed, to close its proximal end with clamp-forceps so that no bile escapes when it is divided. Any mucous membrane which projects from the cut end should be treated with a little pure carbolic acid, or it may be treated like the stump of an appendix by drawing the cut edges of the serous coat together by one or two stitches of fine catgut (p. 798).

The bleeding, chiefly of the nature of oozing, usually yields to well applied pressure; any bleeding points which cannot be tied off must be treated, as in all operations on the bile-passages which present a like difficulty, by leaving on Spencer Wells' forceps for twenty-four or thirty hours, a step which will also facilitate drainage.† The parietal wound will usually be only closed above, as in most cases owing to some uncertainty as to the perviousness of the ducts below,

* A case in which the operation was performed for malignant disease is alluded to at p. 965.

† If oozing from the liver substance is not checked by efficient and prolonged sponge pressure, tamponnading with iodoform gauze or the thermo-cautery must be employed.

or bleeding from adhesions, it will be well to employ drainage together with gauze packing.

Treatment of Biliary Fistula.—This most troublesome affection usually follows on cholecystostomies. It has already been alluded to, but owing to its importance and the difficulties which surround it, a few more words are required. If of any duration it depends, usually, upon one or two causes, a stone impacted in the common duct, or malignant disease of the head of the pancreas. The annoyance from the constant discharge, the difficulty of collecting this, the frequent change of dressings necessitated when the patient is about, the eczema and rawness around the wound, are very great. In the case of an impacted stone if it cannot be felt, and removed or dislodged by manipulations from the adherent gall-bladder, the abdomen should be freely opened by an incision to the inner side of the fistula, exposing the gall-bladder adherent to the parietes; the ducts are then examined and the stone localised in the common duct, and either broken up or pushed on or removed by incision. If the above course is really impracticable cholecystenterostomy must be performed. In the very rare cases where the obstruction is due to contraction which has set in after ulceration due to the long-continued pressure of a stone, the surgeon should try to open up the duct with probes and sounds passed from an opening in the gall-bladder, aided by a finger within the peritonæal sac. Where it is found that malignant disease is the cause of the obstruction, if this be in an early stage (p. 960) the patient's power of repair good and the blood not yet seriously altered, cholecystenterostomy should be performed.

REMOVAL OF PORTIONS OF THE LIVER FOR NEW GROWTHS.

This operation will always remain a rare one from the infrequency of growths which admit of removal. In the two cases alluded to below, which have been recently operated upon, two of the most important conditions necessary for success were present—viz., sufficient projection of the liver beyond the ribs to allow of the necessary manipulations, and a localised condition of the growths.

Prof. Keen of Philadelphia published (*Boston Med. and Surg. Journ.*, vol. cxxvi. 1892, p. 405),* a successful case of partial resection of the liver for a cystic adenoma of the liver. The patient was a woman aged thirty-one. The swelling was believed to be an enlarged movable kidney. When the peritonæal sac was opened by a free incision in the right linea semilunaris, a bluish-white cystic swelling was at once seen to be occupying the extreme right border of the liver, the gall-bladder being close to the inner border of the growth itself was dissected loose, and then the growth itself was removed partly by cutting through the liver substance, four large veins being tied as they were exposed, and partly by enucleation.† After the removal the site the growth had occupied roughly resembled an amputation with its two flaps. These surfaces, though charred, were united with sutures,‡ and gave no after-trouble from sepsis, want of union, or escape of bile

* This helpful paper contains references to other cases; of these, 19 in number, 17 recovered. But of these 2 were only constricted portions of the liver itself, not new growths, and 3 were gummata.

† Every precaution must be taken by the use of iodoform gauze packing, or by suturing the parietal and visceral peritonæum together, to shut off the general peritonæal sac. And in cleansing or draining this the directions already so fully given, pp. 816 and 818, must be followed.

‡ Probably a safer plan would be to tamponnade such surfaces with strips of iodoform gauze, the ends being brought out of the upper part of the incision

The patient made a good recovery, and was in excellent health four months later.

Mr. Mayo Robson brought a case before the Medico-Chirurgical Society (*Brit. Med. Journ.*, March 14, 1896), in which he had removed the gall-bladder and a portion of the right lobe of the liver, weighing half a pound. The operation was performed for a rapidly increasing growth of the gall-bladder, which on exposure appeared to be malignant, and as there was only one nodule of the disease evident in the liver, closely adjacent to the distal end of the cystic duct, it was thought desirable to remove at the same time the portion of liver affected. The growth was a squamous-celled epithelioma. The growths and protruding part of the liver having been encircled with an elastic ligature, and pins so placed as to keep the ligature from slipping, the liver tissue was cut through half an inch from the growth, the pedicle left was as thick as the wrist, and after the separation of the slough a granulating surface was left which gradually contracted. The patient made a good recovery from the operation.

which is left open. In some cases the stump has been fixed in the parietal incision. In four the treatment was extra-peritonæal, the "pedicle" being fixed to the parietal wound, and surrounded with an india-rubber ligature, which was gradually tightened. The tumour which had been thus protruded gradually withered under iodoform gauze dressings.

CHAPTER X.

OPERATIONS ON THE PANCREAS.

TREATMENT OF PANCREATIC CYSTS.

THE only operations on the pancreas to which I shall refer are those required for cysts of this viscus, as these alone are likely to call for surgical intervention. We owe much of our knowledge of the diseases of the pancreas to the exhaustive studies of Dr. N. Senn (*Intern. Journ. Med. Sci.*, 1886 and 1887).

Diagnosis of Pancreatic Cysts.—Sufficient cases have been published to make the following probably reliable:—The swelling, which may date to an accident, appears, usually in an adult, in the epigastric region, is generally accompanied (especially when its increase is rapid) by “*cæliac neuralgia*”—i.e., pains probably arising in the solar plexus—often colicky, or even agonising, and leading to collapse. Dyspepsia, marasmus, and mental depression are often present to a marked degree. The position of the cyst, behind the stomach and transverse colon, and the chemical and microscopical examination of the fluid are well worthy of attention.

Treatment.—Dr. Senn showed that the wisest course was incision of the cyst by abdominal section. The results of attempting to extirpate the cyst have been so unsuccessful as to entirely justify his condemnation of this course.

The following case,* in which I operated at the request of Dr. Newton Pitt, is a good instance of a pancreatic cyst treated by laparotomy, incision, and drainage. I received the following history when asked to see the case, August 21, 1889: The patient was twenty-one. He had received a kick in the abdomen three years before, which had confined him to bed for three weeks. Ever since he had been liable to severe attacks of epigastric pain. He had been markedly jaundiced, was emaciated, and suffered a good deal from nausea and depression. The swelling in the epigastric region was convex and uniform, and reached from below the tip of the ensiform cartilage to just above the umbilicus, and laterally to near the ends of the eleventh ribs. The tumour gave the impression of being attached to some deep-seated structure. There was transmitted impulse synchronous with the pulse, but not expansile. As the swelling had refilled after two previous tappings,† and, as the swelling and the patient's distress were steadily increasing,

* My colleague and I reported this case fully (*Trans. Med. Chir. Soc.*, vol. lxxiv. p. 455). References are given to 30 cases which will be found summarised there by Dr. Pitt. References are also made to 13 cases by Mr. Cathcart in his instructive paper (*Edin. Med. Journ.*, July, 1890).

† The fluid was alkaline, sage-green, sp. gr. 1013, albuminous, and, under the microscope, showing innumerable collections of globular masses of tyrosin crystals. No leucin could be detected. The fluid in these cysts varies a good deal—sometimes colourless and serous, at others it is red and viscid. It will be seen from the account that follows that on each occasion the aspirating needle must have transfixed the stomach. The same thing, with like harmlessness.

laparotomy was performed, August 22, with strict antiseptic precautions. An incision, 3 inches long, was made over the most prominent part of the cyst, $1\frac{1}{2}$ inch to the left of the middle line, extending to within an inch of the umbilicus. The parietal peritonæum having been stitched to the margins of the wound, the lower edge of the liver could be seen moving with respiration in the upper angle, while the rest of the incision was occupied by a smooth reddish surface, which bulged strongly forwards. Taking this to be the front of the cyst, and having ascertained before the operation that the cyst was dull on percussion, I was about to leave this, for twenty-four hours, to become adherent before it was incised. The result proved that, if I had done so, the scalpel would have passed through both walls of the stomach. Before dressing the wound, I again scrutinized the surface of the supposed cyst, and thought I found evidence of involuntary muscular fibre, which threw doubts upon the swelling being a pancreatic cyst. When the supposed cyst was examined between the fingers, it proved to be the empty stomach, stretched very tightly over the subjacent cyst. To get at this, the stomach was drawn upwards, that it might be packed away above under the liver. But here an embarrassing difficulty arose. As I pulled up the stomach, which was tightly jammed between the bulging cyst behind and the parietes in front, the omentum came up into the wound in front of the cyst. The tension of the parts was so great, owing to the rapid increase in the cyst, that there was no room above in which to pack away the omentum. Pushing this to either side, already fully occupied, pulled down the stomach again. I accordingly drew the greater part of the omentum out of the wound.* Some of it was tied with catgut, and cut away; much of it was left heaped up on the abdominal walls on either side of the incision. One or two fine catgut sutures retained the omentum in position. I next scratched through the two layers of omentum, and exposed the surface of the cyst for a space the size of a shilling. There was thus a somewhat conical passage leading from the abdominal incision, through a mass of omentum, down to the anterior surface of the cyst. This last was very vascular, and so tense that it was not thought advisable to put in a guide-suture. The patient passed through the next twenty-four hours fairly well. At midnight, August 23, symptoms of collapse set in (hæmorrhage probably took place at this time into the cyst, a complication which must always be probable, owing to the very vascular surroundings). The patient's pulse at 2 A.M. had run up to 163, and his condition pointed to a fatal ending at no distant date. At 3 A.M. I passed a fine trocar into the cyst, and drew off 12 oz. of deeply blood-stained fluid, which was under very high tension. The sac was then incised and a large drainage-tube inserted. A marked improvement at once set in. A slight discharge of dark treacly fluid necessitated changing the dressing twice a day at first. The wound was all healed in two months (*vide infra*). On another occasion I should prefer to open the cyst at once either by a large trocar and tubing, or by a small incision, keeping the cyst well forwards by means of Spencer Wells' forceps attached to the cut edges. As the cyst emptied, a finger as a guide having been introduced into the cyst and pushed downwards and outwards below the left infra-costal margin, a counter-opening might be made and a large drainage-tube inserted

happened in one of Karewsky's two cases (*Deut. Med. Woch.*, No. 46, 1890). In two cases the preliminary puncture was followed by evidence of peritonitis, and in two by grave collapse attending the escape of fluid from the cyst into the peritoneal sac. Another possible danger is puncture of the transverse colon, which may be tightly stretched over the cyst. If fluctuation can be detected in the infra-costal region behind, or if a thrill can be obtained here from the front, it will be safer to aspirate from behind.

* On another occasion I should divide the omentum above the transverse colon.

into the cyst from behind. This will be shortened from time to time, and left on till from three to five weeks before closing the abdominal incision. Mr. Cathcart left the opening in the front of the cyst open, Mr. A. P. Gould closed his by suture.

Mr. Caird (*Ed. Med. Journ.*, Feb. 1896) acting on Mr. Cathcart's plan of making a counter-opening behind, opened one of these cysts at the back, and not through the anterior abdominal wall, as is usually done. The incision was made along the outer border of the erector spinæ just below the twelfth rib, and a tube inserted. This was kept in for four months, and later on iodine was injected occasionally to promote obliteration of the cyst. The patient was ultimately discharged, with the opening closed. The administration of liquor pancreaticus with the food was thought to have been beneficial. All will agree with what Mr. Cathcart claims for the posterior incision, viz., (1) that the cyst can here be reached extra-peritoneally; (2) that this incision gives better drainage; and (3) that by it there is less risk of a ventral hernia.

The after-history of any case of pancreatic cyst reported as cured by drainage must be carefully watched. It is clear that under certain conditions—*e.g.*, where the cyst is very large, where it has thick walls, and above all where the duct communicates with the cyst and where much of the pancreas tissue remains—**recurrence** is almost certain and complete obliteration by drainage probably impossible. As in most of these cases the intimate relation of these cysts with very vital parts does not admit of their being dissected out, we must be prepared to fail sometimes in our efforts to secure a radical cure. This is shown by the sequel to Dr. Newton Pitt's and my case, which was brought as one treated successfully by drainage, before the Medico-Chirurgical Society (*vide supra*). About a year later I heard that the swelling had reappeared and that the man was about to be operated on again. Later on I was given to understand that the swelling had reappeared a second time, but I have been unable to obtain the needful information. Dr. M. H. Richardson of Boston drew attention to this tendency of pancreatic cysts to recur after drainage.* "Pancreatic Cyst apparently cured by Incision and Drainage. Recurrence. Perforation of the stomach. Death. Autopsy." (*Boston Med. and Surg. Journ.*, vol. cxxvi. 1892, p. 441). At the autopsy it was found that the head of the pancreas was normal and that a tube could be passed from the pancreatic duct into the cyst; about two inches of normal pancreatic tissue were found lying between the cyst and the spleen. From this also a duct could be traced into the cyst." It was very difficult and even impossible at the time of the autopsy to dissect out the cyst from the parts to which it was adherent.

* Dr. Richardson thinks that in some cases the permanent use of a tube will be needful. Mr. A. P. Gould published (*Lancet*, vol. ii. 1891, p. 290) a case of pancreatic cyst which had been treated by drainage, a sinus persisted in spite of treatment, and, three years later, became the site of epitheliomatous infiltration. Dr. O. Ramsey of Baltimore, in a case of a large pancreatic cyst treated by drainage, was obliged to continue the use of a drainage-tube seven months after the operation, as the discharge was still free. (*Annals of Surg.*, Dec. 1895) Dr. Ramsay thinks that in addition to persistence of secretion the large size of the cyst and the tension under which the fluid escapes when the cyst is opened, point to gland substance being present and still functionally active. The last two features it will be noticed, were present in Dr. N. Pitt's and my case, which recurred after an apparent cure.

CHAPTER XI.

OPERATIONS ON THE BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.—OPERATIVE TREATMENT OF TUBERCULAR ULCERATION.—PARTIAL PROSTATECTOMY.—LATERAL LITHOTOMY.—SUPRA-PUBIC LITHOTOMY.—MEDIAN LITHOTOMY.—LITHOTRITY AND LITHOLAPAXY.—REMOVAL OF STONE IN THE FEMALE.—CYSTOTOMY.—RUPTURED BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.

Practical Points in the Diagnosis.—Indications for Operation.—Early and accurate diagnosis is here of the utmost importance.

I. *Hæmorrhage*.—This is of much importance, both in diagnosis and as bearing upon an operation. Thus, in the villous growth or fimbriated papilloma it is this alone which kills. Again, it may be the only symptom. In these growths the chief point is that the hæmorrhage extends over a long time,* occurs spontaneously and suddenly, and without any allied symptoms; it ceases in the same way; the periods of intermission gradually become less, till the bleeding is constant, either rendering the patients utterly anæmic or adding to their misery by bringing about cystitis. These last two conditions may be so marked as to demand an operation. This symptom is most frequent in the villous growth (fimbriated papilloma),† less so in the fibro-papilloma or in the “transitional”

* Mr. R. Harrison (*Intern. Encycl. Surg.*, vol. vi. p. 38) states that in the Museum of St. George's Hospital there is a specimen of a villous tumour attached to the neck of the bladder of a gentleman aged eighty-one. The first attack of hæmorrhage had occurred twenty years before death, and had lasted for eight months, an interval of four years had followed this, and then a recurrence of hæmorrhage, which ultimately proved fatal. Sir B. Brodie also states that the disease occasionally extends over seven or eight years. In a case of Mr. W. Anderson's (*Clin. Soc. Trans.*, vol. xviii. p. 313), of papilloma, the first hæmaturia had taken place twelve years before, then came an interval of a year, followed by recurrence of the hæmaturia, the next interval being shortened to six months, after which recurrence took place fairly regularly every three months.

* The following classification is that given by Prof. Küster in Volkmann's Clinical Lectures:—A. New growths of the prostate—1. Fibro-adenoma; 2. Myxoma; 3. Carcinoma. B. New growths of the bladder—i. New growths from the mucous or sub-mucous coat: 1. Papilloma (including the two varieties of Sir H. Thompson),

growths. Sir H. Thompson lays much stress on the fact that, in these cases, the stream often begins without or with little blood, and ends of a bright-red colour. Again, if the bladder be washed out with an aseptic lotion (p. 995), this becomes deeply coloured after a momentary stay within the viscus.

II. *Sounding*.—This is usually said to be negative, but it should be made use of thoroughly and carefully. In the case of a single, fimbriated papilloma, the sound may give no information unless it happen to detach the growth. In more solid growths—*e.g.*, a fibrous papilloma, a transitional or sarcomatous tumour—irregularity or resistance may often be met with at one spot in moving the sound.* In the mucous polypi of children any movements of the sound may be prevented, and carcinomata, if ulcerated, may give a very distinct, uneven, rugged feel, while the increase of pain afterwards is here very marked. But sounding is of value beyond what it tells at the time. By using the sound with judicious and gentle vigour, particles of a villous growth may be detached for microscopical examination. This may perhaps be aided by washing out with a lithotritty-evacuator as suggested by Mr. Davies-Colley. Several surgeons, I amongst the number, have had cases in which a catheter with large eyes has entangled and detached, as the bladder emptied, processes of the growth. Additional knowledge may be gained by the sensation sometimes given by the catheter as if it were moving against wet wool or sponge, or through delicate seaweed. Every precaution must be taken not to cause cystitis or to set up bleeding by the use of the catheter. If the latter follow, the bladder should be opened without delay. M. Guyon (*Ann. de Mal. des Organ. Gén. Urin.*, 1889, p. 449) points out that in a few cases a pedunculated growth situated near the neck may cause obstruction and other micturition troubles, before hæmorrhage appears.

III. *Examination of Urine*.—This aid has been too much neglected because the naturally present "transitional" epithelium of the bladder may so easily be mistaken for growth-cells. But in the case of villous growths especially, careful examination of the urine should be frequently made, and the patient directed to bring, at once, any white or shreddy particles passed. The sediment of the urine should be also frequently examined microscopically after sounding and washing out the bladder. The delicate papillæ, with their connective-tissue basis supporting hosts of columnar cells with large delicate capillaries, are most characteristic.

IV. *The Cystoscope*.—In certain obscure cases, as where a growth is present for some time without causing bleeding, this instrument will be of much service. But it must not be forgotten that its use entails certain disadvantages. Thus, very easy to use in the bladder of women, in men it is a very different matter. Here, in the deep urethra, it may excite bleeding, it may cause grave febrile disturbance; one case has been related to me, in which difficulty of manipulating it through the prostatic urethra was followed by fatal injury to this part. Such cases are not published.

V. *Cystotomy*.—The cystoscope can help us as to the size and site of the growth—but whether it is simple or malignant,† whether it is merely implanted on the

viz.: (α) Fimbriated papilloma or villous growth; (β) fibro-papilloma. Sir H. Thompson has also described a transitional form of papilloma, characterised by vascularity and cell-infiltration. 2. Fibrous polypi and myxoma, 3. Sarcoma; ii. New growths from the muscular coat: 4. Myoma; iii. New growths from the epithelial and glandular tissues: 5. Adenoma, 6. Carcinoma, 7. Dermoid cyst.

* Thus it may be easy to explore one side of the bladder by carrying the sound over to the opposite thigh, while similar manœuvres to examine the other side are interfered with.

† It is always worth while to remember the vast preponderance of malignant over benign growths of the bladder (Wallace, *Edin. Med. Journ.*, 1893, p. 735). Thus out of eighty-eight cases which Albarran personally examined, seventy-one were

mucous membrane or infiltrating it can only be told by cystotomy, and not always by this. I strongly advise a more extended use of supra-pubic cystotomy to explore and clear up these cases. Where nothing further is done much of the risks of the operation will be removed by immediate suture of the bladder, which will admit of antiseptic precautions being thoroughly carried out.

VI. *Dilatation of Urethra*.—This should always be made use of in a female patient. It is invaluable in clearing up the case, and the incontinence left is slight and of brief duration. *Exploration* by perineal incision. This, if the perinæum is not very deep, the prostate not much enlarged, and if the growth is not very far from the neck of the bladder,* may give useful information, but it is not, in my opinion equal to opening the bladder above the pubes and closing the incision by suture, if nothing more is done. The supra-pubic incision is to be advised in every case. The vaginal incision again, or colpo-cystotomy is not to be relied upon for sufficient room: moreover, if the edges are bruised, it runs the risk of leaving the patient with a most odious fistula.

V. *Exclusion of other Conditions*—e.g., stone, tubercular and other forms of cystitis, also hæmorrhage from the prostate or kidney. In none of these cases, save in the last, is there the spontaneous character which often marks the bleeding of bladder growths. In renal hæmaturia due to growth the bleeding may be spontaneous, and unaccompanied by other evidence. Here the renal region should be thoroughly examined at regular intervals. In tubercular disease of the bladder the bleeding is never as large as in growth, and for a long time occurs with the end of micturition. Other evidence will also be present, and so too with the hæmorrhage of enlarged prostate, which will very likely be preceded by a chill or by retention.

VI. *Failure of Previous Treatment*.—Growths of the bladder being inevitably fatal, whether from hæmorrhage, or pain, or obstruction results, or from these combined, the surgeon is entirely justified in urging an early digital exploration to clear up the case and the question of removal. This may be supra-pubic cystotomy, with immediate suture if nothing more is done, or dilatation of the urethra in a female subject. While it remains as yet uncertain how many of the cases published as cures are really and permanently so, even in the case of the villous growth, it is an undoubted fact that an operation may result in arresting the hæmorrhage completely for years. In other cases, hæmorrhage, pain, and frequency of micturition may all be very largely relieved. Where little or nothing can be done in the way of removal, the free escape given to the urine by a perineal or supra-pubic operation or by dilating the neck of the bladder in a woman may give great relief; where even this fails, the case has, at least, been cleared up.

Choice of Operation.—In my opinion, in all cases, but especially where the surgeon is uncertain as to the size or the number of growths, where the perinæum is very deep, where the prostate is enlarged, or the perinæum small and the pelvic outlet contracted, the supra-pubic method will be safest and give most room. So, too, in the case of a recurrent growth, this method should be employed, as it cannot be told how far the recurrence is widely diffused. The supra-pubic operation is always to be preferred as enabling one to see as well as to touch the growth, as alone giving more room for

malignant, and seventeen simple. Out of twenty-two cases Guyon found nineteen to be malignant.

* If the growth be a very soft one it will be found very difficult to determine by the perineal route which is growth and which is bladder. By the supra-pubic opening the eye will determine this.

necessary manipulations, *e.g.*, the use of an electric lamp in what may be a very difficult operation.*

Only when there is strong reason to believe that the growth is single, or small, and near the neck, may the bladder be explored from the perinæum by opening the membranous urethra, and dilating the vesical neck. But even here I do not recommend it.

In some cases it will be advisable to combine both operations, as the perinæal opening enables the surgeon to use two index-fingers in the bladder at the same time, and also favours drainage, especially where the urine is foul.

In cases where, owing to complete removal having been an impossibility, it is desired to give relief by a permanent opening, a supra-pubic one kept patent by a short curved tube and plate (somewhat like a tracheotomy tube) will be preferable to a perinæal opening, owing to the tendency of the latter to close.

If in doubt as to recommend exploration, the practitioner should remember: (1) That the long intervals between the bleedings teach strongly that growths of the bladder often pass through a long first stage, during which the growth is connected with the mucous membrane only; (2) That, following on the above, infiltration of the deeper coats, and thus glandular infection, is often here long delayed. While the long intervals between the bleedings, and the comparative slightness of the other symptoms, may make the surgeon unwilling to urge operative interference, it is right that it should be very clearly put before the patient that it is in this stage only that any hope of a radical cure can be given, and that later on, when the stage of infiltration is reached, not only is radical cure almost out of the question, but the risk of attempting it and so of perforating the coats is vastly increased. The points that a supra-pubic exploration will clear up about the growth are the number, site, whether accessible or not, and its relation to the ureter, how far pedunculated or sessile,† how far it seems attached to the coats of the bladder. The more the growth approximates the worst of all types of bladder growth—viz., the low-lying, broad-based, fixed, sessile lump, especially if with a sloughy surface incrustated with phosphatic débris, the more hopeless is operative interference.

Operation.—If the surgeon decide to first open the mem-

* It is noteworthy that all the surgeons of widest experience have declared for the supra-pubic method—viz., Sir H. Thompson, Guyon, Volkmann, Dittel, von Antal, &c.

† There is a general belief, I think, that pedunculated growths are usually benign. This is a very dangerous belief. Malignant growths or transitional ones becoming malignant form the very great majority of bladder growths. If the growth is at all thick or succulent, if it is at all infiltrating—*i.e.*, not a merely implanted pedicle—the odds are greatly in favour of recurrence, however thoroughly the growth is removed. Of twenty-eight cases of pedunculated growths examined by Albarran fifteen were malignant." In apparently simple cases recurrence may take place in spite of the most complete operation (*Ibid.*).

branous urethra for purposes of exploration or to ensure drainage he does so in the manner of a median lithotomy (p. 1001), and explores the bladder after dilating the neck with his finger, which is made to enter by a careful insinuating movement along the director, which is then withdrawn. If no growth is felt near the neck, the surgeon, rising, makes firm supra-pubic pressure, so as to bring the upper part of the bladder into contact with his left index.

Usually the surgeon determines to make a supra-pubic opening at once, for the reasons given at pp. 971, 983, and first places a bag in the rectum* and distends it with 8 or 10 oz. of water (p. 995). The bladder is then injected with 8 or 10 oz. of Thompson's fluid (p. 995), either through the penis, or through the perinæal wound by a large catheter, this wound being finally plugged around the catheter with sponges dusted with iodoform, aided, if needful, by the finger of an assistant. The supra-pubic opening is then made with the precautions given at p. 997; when the bladder is distinctly reached, some advise that one or two sutures of carbolised silk are passed across the site of the intended opening into the bladder with a curved needle in a handle. The opening into the bladder is then made (carefully, so as not to divide the underlying silk), the silk is hooked up and divided; by this means two or four sutures are present—one or two on either side—which will serve to raise up the bladder as required, and to keep it well open and within reach during the manipulations needful for the removal of the tumour.† I prefer the use of two Spencer Wells' forceps on either lip of the wound, held by assistants; the threads when pulled upon are liable to tear the delicate tissue of the bladder. The slight bruising inflicted by the forceps is not of importance, as all the opening will not be sutured.

In opening out and exposing the cavity of the bladder specula‡ of wire (solid-bladed ones taking up too much room) will be found very useful, but the need of these and other rarely used and expensive instruments will be less felt if an electric lamp is at hand.

The removal of the growth is effected in different ways, according to its structure. Sharp spoons, curettes, appropriate forceps,

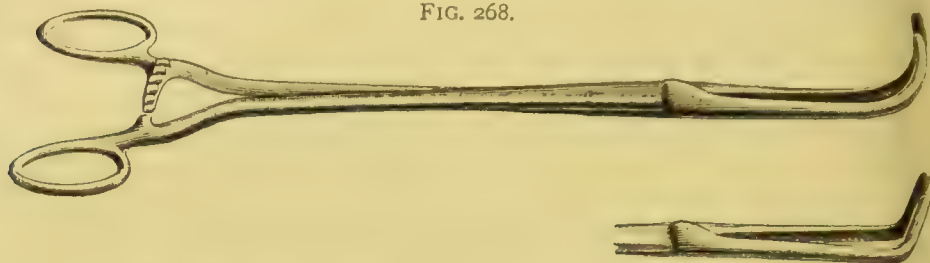
* If the bladder be fixed by the growth the bag will help but little. It should, I think, be always tried, where prolonged manipulations are expected, owing to its steady effect upon the bladder.

† In difficult cases the position of Trendelenberg (p. 981) is always to be employed. The intestines gravitating towards the diaphragm drag upwards the peritonæum and thus the bladder slightly. The deeper parts of the viscus can now be better brought into view, especially with an electric lamp.

‡ Of these special instruments the bladder-speculum with two wire blades invented by Watson of Boston (*Lancet*, Oct. 18, 1890) and the three-jawed speculum of Bruce Clarke (*Brit. Med. Journ.*, July 4, 1891) are the best. Injecting the rectum-bag first and then the bladder secures the maximum of elevation. It is always well to use a metallic catheter if possible, in distending the bladder, so as to have a guide later on.

straight, and of different curves (Fig. 268), Jessop's prostatectomy forceps, those with serrated blades introduced by Sir H. Thompson, Paquelin's cautery, and a small *écraseur* with a violin-string ligature, should be at hand.* When a growth has a sufficiently long pedicle, it should be dragged up and twisted or cut away a little above its attachment to the mucous membrane. This and the adjacent mucous membrane† must then be deliberately removed.

FIG. 268.



Useful forceps for twisting away of bladder growths or hypertrophied prostate tissue. (R. Harrison.)

with blunt-pointed scissors. If the cut edges can be united by catgut sutures, so much the better; if not, the wound must be left to granulate.‡

In more doubtful cases—cases transitional between innocent and malignant—the following test of Albarran's may be useful: "The gliding or otherwise of the mucous membrane ought to regulate the depth of the removal of the growth; wherever the mucous membrane seems fixed to the sub-mucous coat, it would be better even in pedunculated growths to resect the entire wall, a step still more essential in small sessile tumours" (*vide infra*, Partial Resection of the Bladder, p. 977). When the growth is of firmer consistence

* The galvanic *écraseur* should never be used unless other instruments have failed. The loop will, no doubt, shear away, without hæmorrhage, large masses which, from their size, poorly marked pedicles, and vascularity, are very difficult to deal with otherwise. But its liability to introduce septic complications, and the difficulty of manipulation in a deep contracted space, are grave objections to the cautery. If the surgeon is driven to use an *écraseur*, he should employ the ordinary wire one, on account of the above mentioned septic complications. Mr. Bryant (*Lancet*, 1886, vol. ii. p. 1076) found the following method useful in the case of a bladder which appeared to be filled with villous growth: A great deal having been removed by forceps, the bladder was scraped throughout, the walls being wiped rather roughly with a new sponge tightly tied round a forceps. Hæmorrhage recurred six months later, persisting for a week; it then stopped, and the man was doing well eighteen months after the operation. Used in a similar case this method has been inefficient and followed by rapid recurrence.

† "Even in the most simple cases the growth should be more extensively performed than is the custom, and all the mucous membrane in contact with the growth should be removed. We have seen the possibility of infection by contact with the mucous membrane, and the plan I propose is to eradicate the epithelial neoplasms that may exist around the growth," Albarran (*loc. supra cit.*).

‡ "Experiment proves that the mucous membrane regenerates itself after removal, and this ought to lead us to remove freely all suspected portions" Albarran (*loc. supra cit.*)

and more of the sessile type, it should be clipped away with scissors, punched out (if firm) bit by bit with Jessop's prostatectomy-forceps, scraped down with the nail or curette, or partly nibbled, partly twisted out, by Sir H. Thompson's serrated forceps.* This surgeon thus describes the use of the forceps: Having, with his forefinger, first made himself familiar with the exact position and size of the tumour, the surgeon inserts the forceps, guided only by the knowledge thus acquired, and makes a decided snip on the tumour; then, by moving the forceps in different directions, he makes sure that he has the growth within their grasp. "Above all things, he is not to pull forcibly, but to press firmly the blades together, biting or chewing a little, if I may use the terms, with the extremities of the blades without changing the original situation of the bite or grasp. Then a little twisting movement may help to disengage the mass, which, if accomplished, the forceps will be felt free, and may be withdrawn with their contents, after which the finger enters to feel what remains and what more must be done in order to complete the removal. Let me remark, whenever the forceps has removed a portion, however small, the instrument should never be re-introduced until the finger has again examined the interior" (*Brit. Med. Journ.*, 1884, vol. i. p. 1240; *Tumours of the Bladder*, p. 80).

The same surgeon thus draws attention to the great risk of making strong supra-pubic pressure while forceps are being used: "If that pressure is considerable, it forces the upper wall of the bladder into its own cavity, and thus gives the growths a larger contour than they possess, and makes them apparently salient to a much greater extent than they really are. Thus, an eager or inexperienced operator, unaware of the effects of strong supra-pubic pressure, might be led to seize the mass offered to the forceps through the influence of this pressure, and, under the belief that it was a large growth, he might inflict a fatal wound by crushing a double fold of the coats of the bladder, and so make an opening in the peritonæum. To avoid such a catastrophe, it is only necessary, first, to decline the attempt to destroy any growth which is clearly not sufficiently salient to admit of complete or nearly complete removal; and, secondly, never to employ the forceps while forcible supra-pubic pressure is made—at least, no more pressure than is desirable just to steady and support the bladder and the parts adjacent."

When the mass of the growth has been removed by the nail, curette, or twisting-forceps, the base must be destroyed as effectually as possible by Paquelin's cautery,† or partial resection must

* Whatever method is used, the surface left should be as smooth as possible, in order to diminish the risk of phosphatic deposit.

† Though this method has the sanction of M. Guyon, it is only to be used in the case of large growths where partial resection is out of the question. Besides the inherent risk of sepsis it leaves a wound slow in healing, and a source of obstinate cystitis.

be performed (p. 977). Quiet nibbling and careful torsion will remove the bulk of the attachment of the growth, but if we are to progress in our surgery here, a radical cure can only be hoped for in growths that infiltrate the bladder wall by treating them as we do malignant disease elsewhere—*i.e.*, operating early and removing the whole thickness of the tissues affected, as long as this step is not foolhardy (see Partial Resection, p. 977). Finally, two warnings of Mr. Fenwick's must be remembered by those who trust to forceps and nibbling or twisting. "Munching the surface of a carcinoma and leaving the base is tantamount to an increase in the rapidity of its growth. I have reason to believe that the munching or squeezing of the healthy mucous membrane in the neighbourhood of the growth fosters the appearance subsequently of growth in the traumatised areas" (*Brit. Med. Journ.*, 1895, vol. ii. p. 906).

Hæmorrhage.—This must be met by sponge-pressure, occasionally ligature, or washing out with mercury perchloride solution, 1 in 6000, at a temperature unpleasantly hot for the hand. If it persists in spite of the above, and if the bleeding point is on the floor or above the neck, gauze tamponading must be employed.

Two American surgeons, Dr. Keyes and Dr. Cabot, have made use of this successfully (*Med. Review*, Sept. 17, 1892). Bichloride gauze is cut into pieces, some twenty in number, these having sides six inches long on one aspect, three on the other, and four inches in the middle. In the centre of the three-inch, a small white shirt-button is attached, which securely transfixes the tampon and has a long double piece of silk running away on the six-inch surface and a single piece on the three-inch one, a piece of silk is also attached to each of the four corners. The tampon is introduced thus: a soft catheter is passed into the bladder and out through the supra-pubic wound. The loop of double silk is then tied on to its end and thus drawn out at the meatus. The catheter being removed traction on the silk draws the gauze down on to the bleeding surface, and the double silk loop is then tied at the meatus over a piece of gauze. If there be a perinæal wound, the silk is drawn through these incisions and tied tightly over a gauze perinæal pad. The removal of the tampon is effected by cutting the knotted silk and pulling on the five other pieces, the ends of which have been brought out of the supra-pubic wound.

When the operation is completed the question will arise as to the advisability of suturing the bladder. In the after-treatment of all supra-pubic cystotomies, the chief nuisance, and a very great one, is constant soakage of the dressings by the urine. This should be avoided whenever the following conditions make the use of sutures safe. (1) Efficient suturing, with silk or catgut. If the mucous membrane be stitched, a continuous suture of catgut must be employed, and a row of Lembert's sutures externally taking up the muscular coat only. (2) Efficient emptying of the bladder. (3) Arrest of bleeding, otherwise the catheter will be blocked, the

distress great, and much tension will be thrown on the stitches. (4) An aseptic condition of the urine. (5) An operation in which the manipulations have not been very prolonged and difficult, and one especially in which there has not been much disturbance of the *cavum Retzii*. If the surgeon is wisely cautious about suturing the whole of the bladder wound, he should suture it almost completely, and leave in a small drainage-tube, putting in one or two provisional sutures which he will tighten up in a few days, when the risk of hæmorrhage and extravasation has passed away. When the conditions given above are not present, and suturing the bladder involves too much risk, the cut edges of the bladder should be united to those of the lower part of the parietal wound with catgut, and an india-rubber catheter lengthened by a piece of drainage tube, passed along the urethra, and out at the supra-pubic wound. Several holes should be cut in the part that is to lie within the bladder. Bringing the tube out above the pubes facilitates washing out the bladder both ways.

If a catheter thus inserted does not drain, the only way to save the patient from the annoyance and risk of constant soakage of urine is to employ syphonage, a method more easily written of than efficiently secured.* Or a trial may be made of placing fine catheters within the ureters and bringing these out, inside tubes, through the supra-pubic wound.†

Partial Resection of part of the Bladder for Growths.—A few cases have been recorded with a sufficient amount of success to justify a repetition of the operation in selected cases. The growth must be situated somewhere in the upper or middle zones of the bladder. In cases where the growth is near the *bas-fond*, or in the vicinity of the ureter resection is out of the question, and we must be content with careful abrasion with or without cauterisation at a red heat. Where the vertex or neighbourhood is the seat of the growth Antal's **extra-peritonæal method** should be followed. By this a large amount of the upper part of the bladder may be removed, but the farther the resection is carried the greater is the difficulty of stripping off the peritonæum and of course in closing the gap.

* The best means of draining the bladder is one described by my friend Mr. Cathcart, of Edinburgh, (*Brit. Med. Journ.*, 1895, vol. ii. p. 968). Besides a douche-can, some india-rubber tubing and a pail, a screw-clamp, a small glass **Y** or **T** tube, a second piece of glass tubing bent like a capital **S**, and a third piece bent at a right angle to go into the bladder, are required. The can filled with water is fixed over the patient's bed, the **Y** tube is fastened with a large safety-pin to the edge of the mattress opposite the patient's pelvis. To one limb of the **Y** tube is attached about a foot of tubing which is connected with the can, to the other a right-angled glass tube, which dips into the bladder. To the stalk of the **Y** tube a third bit of tubing is attached which is fixed below to the **S** glass tube which by means of another bit of tubing should end under some aseptic lotion. The apparatus being in position the screw-clamp which controls the rubber tubing between the irrigator and one arm of the **Y** tube is then relaxed, so as to allow the water to run very slowly, in fact, only by drops. It accumulates in the **S** tube, and as it tends to run out produces a negative pressure in the other arm of the **Y** tube—*i.e.*, the one connected with the tube in the bladder, thus withdrawing the urine.

† Schede has thus kept a tube-catheter in one ureter for several days without any harm resulting.

The peritonæum is much more easily peeled off when the bladder is full than when it is empty. The edges of the wound in the bladder should be closed with silk sutures as completely as possible. When the resection has been so complete that the gap cannot be closed, its edges must be united to those of the parietal wound, and the opening closed later on by a plastic operation.

A good account of a case of resection of part of the lateral wall and disease of the bladder is given by Mr. H. Fenwick (*Clin. Soc. Trans.*, vol. xxvii. p. 164). The patient was a man, aged forty-six. The growth, an epithelioma, had been removed twice before, the first time by the perineal route, the second time supra-pubically, from a spot to the left of the orifice of the left ureter. "On opening the bladder supra-pubically, the growth was found to have recurred in the scar of the previous operation. It was now a smooth, sessile epithelioma, $1\frac{1}{2}$ inches by 1 inch. The base was indurated, and the infiltration had involved the muscular and sub-mucous layers, for they were glued to the tumour. In order to gain free access to the left lateral wall of the bladder I drew my knife horizontally through the left lower abdominal muscles, the incision commencing at the supra-pubic opening, and ending at a point above the inner third of Poupart's ligament. Stripping off the peritonæum from the front wall of the left pelvis, I kept it packed upwards with sponges. I then resected the growth by cutting away with scissors it and the entire thickness of that part of the bladder which was subjacent to it. The bladder incision commenced at the median opening, and passed directly to the left until the upper margin of the growth was reached. It then proceeded round the tumour. The left side of the trigone was almost involved, but the ureteral orifice was not encroached upon. The hæmorrhage was not severe and was easily controlled by a couple of dozen Spencer Wells forceps." The edges of the bladder wound were drawn together by catgut sutures which traversed only the muscular layers, a small supra-pubic opening being left for drainage. This wound and that in the abdominal wall healed quickly, and two years later (*Brit. Med. Journ.*, 1895, vol. ii. p. 907), Mr. Fenwick stated that the patient was at work in good health. All will agree with the three conditions which Mr. Fenwick considers necessary before such operations are undertaken: (1) A single growth, slow and dense. (2) Absence of cystitis. (3) Sufficient *vis* on the part of the patient to bear so serious an operation.

If it is decided to attempt **intra-peritonæal resection**, as of a portion of the lower part of the bladder, the following directions of Albarran may be useful. A preliminary partial resection of the symphysis as advised by Helferich is first performed. The recti and pyramidales are detached above, and the external obturator below and externally, the periosteum is then carefully reflected and sufficient of the bone removed by an osteotome and cutting forceps to expose the lower part of the bladder.* The bladder having been freely opened in front, and the escaping urine carefully removed with gauze sponges, the peritonæal sac is opened, and the intestines carefully packed away with sponges. We will suppose that it is decided to resect part of the trigone and *bas-fond* comprising one ureter. A bougie is passed into the ureter, the part to be removed is taken away from within, a hand introduced into the peritonæal sac and behind the bladder, keeping touch of the catheterised ureter and guiding the scissors. A stitch is then passed through the ureter so that it can be easily pulled up and cut across where desired. Sutures are then passed across the lower vesical wound, and some having been tied, a hole is made in the posterior wall of the bladder, the ureter is pulled through, split longitudinally for a short distance, and its mucous membrane sutured to that of the bladder. If possible, one or two sutures are put in from outside to strengthen the point of junction. When this is made complete a catheter is passed into the ureter and

* This step gives but little extra room, and opens up cancellous tissue and thus fresh sources of septic phlebitis.

brought out through a tube through the supra-pubic wound. The bladder wound is closed round the tube, and the space between the bladder and the pubes is kept packed with iodoform gauze.

*Complete Extirpation of the Bladder.**—This operation has been performed by Bardenheuer and Gussenbauer. The first successful case was by Paulick of Prague. Clado has had a second. Both of these were in women. In each case the operation was done in two stages, the ureters being first diverted to and secured in the vagina, and then, about three weeks later, the bladder removed. The vagina by the second operation was converted into a pseudo-bladder. Paulick's patient was alive 2½ years after the operation, and in fair comfort.

Causes of Death after Removal of Bladder Tumours.

1. Shock. Mr. R. Harrison (*Lancet*, 1884, vol. ii. p. 678) records a case of a man, aged forty-two, who died somewhat suddenly, apparently from shock, twelve hours after removal of a villous tumour by the perineal method. The hæmorrhage, which had begun four years before, had for a year been persistent and considerable.† 2. Exhaustion. 3. Cellulitis. 4. Failure of the kidneys. Evidence of this will of course be sought for before. It is most likely to occur in growths which from their position have obstructed the outflow of urine. 5. Injury to the bladder and peritonitis. Mr. Bryant (*Lancet*, 1886, vol. ii. p. 1077), mentioned a case in which a fibrous polypus was drawn from the fundus into the perineal wound and snipped off. The man died of peritonitis, and a small hole was found in the bladder at the site of the removed polypus. 6. Recurrence. This may appear first in the cicatrix of the wound. 7. Abscess in the track of the apparently healed wound, bursting into the peritoneal sac (Sir H. Thompson, *Clin. Soc. Trans.*, vol. xxi. p. 46).

OPERATIVE INTERFERENCE IN TUBERCULAR DISEASE OF THE BLADDER.—

My own experience in several of these cases and a study of what others have published leaves me strongly of opinion that operative interference in the form of cystotomy is rarely justifiable here. My reason for this opinion will be gathered from the following **Indications and Cautions.** (i) It is an accepted fact by all careful surgeons that in tubercular affections in which it is not possible to remove the mischief, operative interference may do more harm than good. Under such conditions the manipulations only irritate early tubercle into activity, and light up again obsolete or quiescent tubercle, besides causing certain dangers‡ peculiar to this viscus—viz., cystitis and pyelitis. Again, to show how useless and even harmful will be operative interference in the early

* A paper by M. Chevalier (*Arch. Gén. de Méd.*, t. ii. 1894) contains much information on partial and complete resection of the bladder.

† Mr. Harrison, in illustration of the sudden and excessive bleeding to which villous tumours are liable, even when they appear comparatively quiescent, has published (*Liverpool Med. Chir. Journ.*, July 1884) a case where death took place from this cause in nine hours. In this instance slight hæmaturia had existed for some months previously, but no operation had been performed. Mr. Morton has drawn attention (*Lancet*, 1896, vol. i. p. 480) to the possibility of secondary hæmorrhage. In his case a papilloma had been removed supra-pubically, the pedicle being cut through with scissors. Severe bleeding took place on the third day, necessitating opening up the wound. The patient recovered.

‡ Another ill result which is very possible here is rupture by even a moderately distending injection of a contracted, rigid bladder the seat of long-standing tubercular mischief, and one emptied for some time by irritability and incontinence. I would refer my readers to two such cases candidly published by Mr. H. Fenwick in his instructive book, *Cardinal Symptoms of Urinary Diseases*, p. 200.

stage of tubercular mischief—a stage in which alone can operative interference be expected to be curative—let us consider what are the conditions present at this early stage. To put it briefly, it is not one suitable for curetting, &c., as is often the case with tubercular mischief elsewhere.* The mucous membrane is swollen, very vascular, velvety, at times gelatinous. Any ulcers present, are often small, even minute and numerous,† so that it is impossible to make sure of efficient curetting, especially when any one familiar with the interior of the bladder knows how quickly a little bleeding hides the field of operation, and the fact that the mischief is usually most marked on the posterior wall, trigone and neck. (ii) For these reasons I am strongly of opinion that in the earlier stages we should treat tubercular disease of the bladder not by operation‡ but by improving the hygienic surroundings, especially, whenever it is possible, getting the patient to be much in the open air, if possible by the sea, teaching him to wash out his bladder with iodoform emulsion and dilute mercury perchloride lotion, and in the case of a woman, giving an anæsthetic at intervals and swabbing over the mucous membrane with a solution of AgNO_3 ʒij—ʒj, the neck having been rapidly dilated. (iii) The cases that call for operative interference are those in which what I may be allowed to call hygienic treatment has failed, or in which the case has got beyond this, where pain is incessant, micturition frequent—e.g. every half-hour day and night, with much tenesmus, and where opiates are required to afford sleep. There should be no advanced disease present of the other urino-genital organs, kidneys, lungs, &c. (iv) The supra-pubic operation is always to be preferred. The perinæal gives very little room (p. 983), and moreover has the great drawback that a tube thus introduced will very likely press upon the neck, &c.

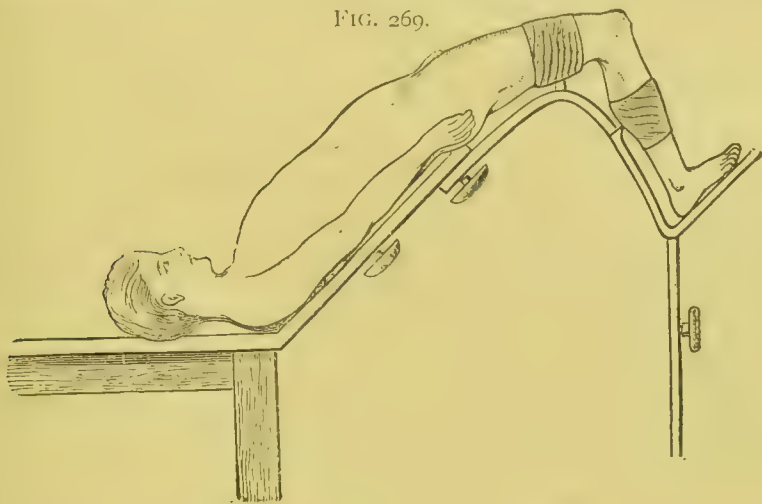
* Prof. Guyon reported (*Ann. des Malad. des Voies Urin.*, Nov. 1889), very fully, four cases which he treated by curetting and the cautery after a supra-pubic cystotomy. One of the four died, two years after the operation, the patient having a persistent sinus and being bedridden most of the time. One died within the year, and one within about three months of the operation. The fourth had survived four years.

† The following is a good description of a condition often present in these cases: (J. Bell, M.D., of Montreal, "Treatment of Tuberculosis of the Bladder by a Supra-pubic Section," *Journ. Cutan. and Genit. Urin. Dis.*, 1892, p. 298). "The trigone and a band of about an inch in depth around the urethral orifice were the seat of many superficial ulcers, varying in size from that of a split pea to irregular patches as large as a five-cent piece. The mucous membrane of the whole fundus of the bladder was also studded with small tubercles which had not advanced to the stage of ulceration nor, indeed, even to the length of showing signs of caseation. The ulcerated patches were scraped and cauterised, but the little non-ulcerated tubercles were left untouched. They were so numerous that it would have been impossible to deal with each one singly." Mr. Battle's case (*Clin. Soc. Trans.*, vol. xxiii. p. 201) which was greatly benefited by scraping after other treatment had failed, owes its success largely to the condition found, which was, I think, a very rare one. The ulcerated surface was single, though very extensive, spreading over the left lateral and posterior wall, from the trigone almost to the summit, with the bladder relaxed. After the ulcer had been scraped, it was dabbed over with a solution of chloride of zinc (30 gr. to ʒj). The patient was seen nearly a year later, soundly healed and able to hold her water for three hours at a time. It is not stated whether pyrexia was then present.

‡ Dr. L. Bolton Bangs of New York, whose experience in diseases of the genito-urinary organs is a very wide one, thus expresses himself on this matter "After faithful and zealous efforts to relieve by surgical interference the local symptoms of these cases, I have been forced to the conclusion that the less instrumentation we resort to the better."

trigone, parts very liable to be attacked by tubercle. Again, this opening has a great tendency to close before the full benefit of drainage has been secured. The vaginal opening seems to me to be liable to the same objection as the perineal—viz., that the vesical end of a tube thus introduced is very likely to rest against an ulcerated surface. (v) The patient should be warned that supra-pubic drainage often involves prolonged confinement to bed, and that the discomforts which must attend the constant soakage of urine are only to be partially met by the use of large absorbent pads. (vi) The tube should, if possible, be withdrawn in about three weeks, and, as soon as the wound is closed, every effort should again be made to place the patient under the best hygienic surroundings, to the necessity of which I have alluded above. Hospital patients should be got into better air at once. But too often the after-treatment of supra-pubic cystotomy for tubercular cystitis resolves itself into the following dilemma. If the opening is closed all the pain, &c., soon recurs; if it is kept open there is much difficulty in preventing noisome soaking. A tube and plug

FIG. 269.



Trendelenberg's position. (R. Harrison.)

worn in the supra-pubic sinus rarely acts well in these cases, where the bladder is often small, contracted and thick-walled. (vii) The patient may enjoy years of fairly active and happy life after a supra-pubic cystotomy, if the opening has closed within a reasonable time of the operation, but he will be liable to other outbreaks of tubercular mischief which were probably present, though quiescent, at the time of the cystotomy—e.g., tubercular testis and kidney.

Operation.—The details of a supra-pubic cystotomy are so fully given at pp. 973, 994 that it is needless to repeat them here. I will only add the caution that great care must be taken in distending these bladders (p. 979). Four to six ounces will be as much as can usually be injected with safety. The bladder is first opened and its interior exposed with some suitable speculum (p. 973) aided, if needful, by the Trendelenberg position (Fig. 269). Any ulcers should be carefully and thoroughly curetted or cauterised with a fine point of the Paquelin's thermo-cautery, iodoform rubbed over the surface or left in, in the shape of the emulsion. To any very vascular, gelatinous-looking mucous membrane, not ulcerated, a solution of AgNO_3 5ij—5j* should be applied on a small sponge on a holder.

* This may appear strong, but it gives very marked relief. In women it may be applied at repeated intervals, after dilatation of the urethra. If it should give much pain, which, in my experience, it rarely does, a solution of sodium chloride may be injected.

The following is a good instance of the relief which supra-pubic cystotomy may give in a very obscure case :

In May 1890 I was asked by Dr. Cock and Dr. Hodgson, of Exmouth, to explore the bladder of a gentleman, aged fifty-seven, suffering from painful cystitis, hæmaturia, frequent micturition, to which general treatment, washing out the bladder and drainage by a catheter, had failed to give any relief. Calculus being excluded by sounding, and there being no rectal enlargement of the prostate, I expected to find a small malignant growth, as the symptoms were too urgent for prostate trouble, and as this gland was not enlarged either to the finger or the sound. The bladder having been opened and emptied by the supra-pubic method, at first appeared normal save for some sub-acutely inflamed rugæ which stood out very distinctly on the right lateral aspect of the neck of the bladder. A small electric lamp at once showed amongst these folds two ulcers each about 1 inch by $\frac{1}{2}$ inch, oval in shape, with muscular fibre clearly exposed on their floors, their edges neither thickened nor indurated. They were scraped with a sharp spoon, and iodoform was then rubbed into their surfaces. The patient made an excellent recovery, and now, six years later, remains quite well. In this patient, with a deep fat perinæum, I should never have detected the ulcers by the perineal route.*

PARTIAL PROSTATECTOMY.

We owe our knowledge of what this operation can do to the late Mr. McGill, of Leeds (*Brit. Med. Journ.*, Oct. 19, 1889).† The following propositions are taken from his paper: i. Prostate enlargements which give rise to symptoms are intra-vesical, not rectal. Thus prostates of immense size which project towards the rectum cause no urinary trouble, while severe symptoms may supervene when the prostate on rectal examination is apparently of normal dimensions. ii. There are many varieties of the intra-vesical growth. We find (1) a projecting middle lobe—pedunculated or sessile, (2) a middle lobe with lateral lobes forming three distinct projections, (3) the lateral lobes alone, (4) a pedunculated growth springing from a lateral lobe, and (5) “a uniform circular projection surrounding the internal orifice of the urethra.” This variety, described by Brodie, is not unfrequent, it surrounds the urethra like a collar, and projects for a variable distance into the bladder. iii. In many cases self-catheterism is the only treatment required. iv. That when this fails, or is unavailable, more radical measures are necessary. v. That this treatment, to be effectual, should (1) for a time thoroughly drain the bladder; (2) permanently remove the cause of the obstruction. vi. That the supra-pubic route is preferable to the perinæal for prostatectomy. Most surgeons will agree with this; the question is alluded to at p. 971, and again below. This operation was short-lived, as it was laid aside for the much less severe one of double castration. This step has given such encouraging results (p. 1068) that it will probably replace prostatectomy in those cases which call for some operative interference. **Indications.**—As double castration, seem to give sufficient relief at a very much smaller risk, it appears to me that prostatectomy should be confined to the following cases: (1) Where one or more calculi coexist with an enlarged prostate. I have myself operated on two such

* Possibly this was a case of the “solitary” ulcer of the bladder described by Mr. H. Fenwick (*Brit. Med. Journ.*, 1896, vol. i. p. 1133).

† Much information will be found in the following papers: Watson, *Ann. of Surg.*, 1889, pp. 1-27; Belfield, *Amer. Journ. Med. Sci.*, November 1890; Moullin, *Brit. Med. Journ.*, 1892, vol. i. pp. 1185, 1250, 1294; White, *Ann. of Surg.*, 1893, p. 152; Woolsey, *Journ. Cut. and Gen. Urin. Dis.*, July and August 1895.

cases.* (2) Where the operation of double castration fails, as it may, perhaps, in some very firm fibrous growths. (3) When a patient refuses double castration but is willing to submit to the greater risk which has been fully explained to him. The cases I consider to justify operative interference are given under the heading castration (p. 1069). The patient will, of course, be got into as satisfactory condition as possible, by attention to aperients, baths, diet, drugs, such as sandal-wood, and washing out the bladder.

Choice of Operation.—Much has been written on the merits of the supra-pubic and perineal methods. The supra-pubic operation has the great advantage that by it the enlarged prostate can be best seen, felt, examined and operated upon. It is much more generally applicable, as by it the middle and lateral lobes can be sufficiently removed. It admits of our doing this, aided by an electric lamp if needful, with much more precision and completeness. On the other hand the perineal route gives much the best drainage and is best suited for the removal of sub-urethral growths, and some cases of enlargement of the lateral lobes, *e.g.*, where this is not only intra- but extra-vesical and so closing the prostatic urethra. These cases are, however, rare; as a rule we have to deal with hypertrophy of the median lobe and of the intra-vesical aspects of the lateral lobes, and all the work that is required can be done from the interior of the bladder. The perineal route has the serious drawbacks of giving very little room; by it operating is done in the dark; in patients with a deep, fat perineum the “perineal distance” may make it quite impossible for the operator to get into the bladder and do anything here to obstructing median or lateral lobes. For these reasons I consider that the perineal route, adopted by itself, should be reserved for cases where the patient is very feeble, where the bladder is atonic, contracted and rigid, where there is cystitis, renal degeneration, cases where the surgeon desires to secure drainage and wishes to do as little as possible. In such, if the perineal distance is not too great, the surgeon may employ the perineal method, doing more or less according to what he finds, the way in which the anæsthetic is taken, &c. As a rule the surgeon should begin with the supra-pubic method, adopting the perineal afterwards, if he finds it necessary, in order to secure a low-level route by the removal of extra-vesical lateral or sub-urethral enlargements, or to secure efficient drainage.

Operation.—The full accounts of supra-pubic cystotomy given at pp. 973 and 994, should be referred to; only those points which relate to the special technique of prostatectomy, will now be given. The quantity of water (p. 973) injected into the rectal bag, especially when the prostate is abnormally hard, should not exceed six to eight ounces. Where the bladder is contracted with

* In one, the patient, aged fifty-eight, was in a condition of extreme misery from cystitis, dysuria, tenesmus, and the catheter had to be resorted to every ten minutes. By supra-pubic cystotomy I removed a calculus and prostatic tissue from the median and lateral lobes weighing $\frac{3}{4}$ ounce. He made a good but slow recovery, the sinus being very tardy in closing. Two years after he was holding his water for three or four hours in the day, and was only disturbed once at night. The residual urine amounted to about half an ounce. In the other patient, a calculus and great vesical enlargement of the prostate coexisted in a man of fifty-nine, whose kidneys we knew to be damaged. After removal of the calculus and $1\frac{3}{4}$ ounces of enlarged prostate the patient did well for two days. An injection of morphia had produced such grave symptoms that I forbade any more being given. The patient's restlessness being troublesome, the house-surgeon, thinking that he knew best, disobeyed my directions and repeated the morphia. Contracted pupils and stupor quickly followed and the patient sank. At the autopsy the kidneys were granular; the remains of the prostate showed the usual ragged surface, but, under the circumstances, not an unhealthy one.

thick non-distensible walls, it will usually be inadvisable to perform this operation. A catheter left in the bladder, till this is opened, expedites the operation. Mr. McGill advises that the bladder be stitched to the cut edges of the wound (p. 999) before any attempt is made to remove the prostate. If this is done it will interfere with the subsequent suture of the bladder which I recommend below. I think the same end can be secured by holding the bladder well up with a pair of Spencer Wells' forceps on either side, each taking hold at a point opposite to the part to be left open when the sutures are inserted (*vide infra*). Enucleation is to be performed as much as possible by the finger. This not only prevents hæmorrhage but the finger will turn out far more intelligently, safely and quickly, much larger pieces than any vulsellum or punching-forceps. First, however, a way must be made for the finger. This is effected by taking away any projecting portions with such forceps as Jessop's. These quickly remove the overlying mucous membrane and the superficial part of the overgrowth. The parts removed, however, are very small and, save as a means of making room for the finger, this instrument will be found most inferior. A better plan is that described by Dr. E. Fuller of New York (*Journ. Cut. and Gen. Urin. Dis.*, June 1895, p. 232). The bladder having been opened the extent of the prostatic enlargement and the site of the urethral opening are determined: "A pair of rough, serrated-edged scissors with a long handle grasped in the right hand are slipped along the left forefinger into the urethral opening, and are made to cut through the bladder wall in that region. The cut extends from the lower margin of the internal vesical opening of the urethra backward for an inch or an inch and a half. The blades of the scissors being rough and serrated, make an incision which bleeds but little. Then one of the forefingers, whichever the operator may find the more convenient, is slipped through the vesical hole made by the serrated scissors, while at the same time the fist of the other hand makes firm counter-pressure against the perinæum. By means of this counter-pressure the prostatic growth is brought well within reach of the forefinger of the other hand, which is employed all the time in enucleating the obstruction *en masse*, or piece by piece, as the case may be. This enucleation should not be desisted in until all the lateral and median hypertrophies, as well as all hypertrophies along the line of the prostatic urethra, have been removed." Dr. Fuller states that owing to the small amount of bleeding he has always found it feasible to sew up the supra-pubic incision as described below, and that he has never had trouble with secondary hæmorrhage. A perinæal section is next made and a large-sized rubber tube passed through the perinæal incision, and that through which the prostate was enucleated, into the bladder. After this hot-water irrigation is employed for some time to stop oozing. Next, the supra-pubic wound is closed by a deep layer of catgut sutures which include the bladder wall, and by a more superficial layer of silk-worm gut. The middle of the incision is not closed, but a deep provisional salmon-gut suture is inserted here, taking up the walls of the bladder and the abdomen. A drainage-tube is inserted, and when this is removed in four or five days the provisional suture is tightened up. Six cases of prostatectomy, five of these operated on by this supra-pubic method, are given by Dr. Fuller; all were successful.

After the surgeon has removed all that he considers necessary from within the bladder he must carefully examine the urethra both with his finger and by full-sized catheters passed from the meatus. Belfield attaches great importance to this. In one of his cases after removing from the left lateral lobe as much as a walnut, he found that there was still an obstruction in the prostatic urethra to the passage of a catheter. By perinæal section a rounded mass was shelled out.

Hæmorrhage must be arrested by the means given at p. 976.

The amount removed must vary with each case. Prostatic tissue is not heavy, and any amount over 1½ ounces will be rarely removed. Mr. Buckston Browne

(*Clin. Soc. Trans.*, vol. xxii. p. 274) removed in one case gland tissue amounting to nearly 4 ounces. A good recovery followed.

LATERAL LITHOTOMY (Figs. 270, 271, 272).

The lateral operation will be described under the following heads :

A. Preparatory Treatment.

B. Passing the Staff. Possible Difficulties.

C. Finding the Stone. Possible Difficulties.

D. Entering the Bladder. Possible Difficulties.

E. Extracting the Stone. Possible Difficulties.

A. Preparatory Treatment.—For a week or so before the operation the diet should be bland, so as to tax as little as possible jaded kidneys—*c.g.*, milk, barley-water, light puddings, and a little fish. If alcohol is needed, some sound spirit, well diluted, should be given. Baths should be taken regularly, the bowels well moved, and an enema given on the morning of the operation, and care should be taken that all this has come away.

B. Passing the Staff.—This step, however simple and easy usually, presents occasional difficulties, the more trying, because perhaps unlooked for ; they are—

- (1) Spasm, from the urethra not being used to instruments.
- (2) Stricture. (3) A false passage. (4) An enlarged prostate.
- (5) An enlarged prostatic sinus, into which the end of the sound passes. Mr. Buckston Browne's staff meets the last two, admirably.

C. Finding the Stone with Sound or Staff. Possible Difficulties.

(1) The stone may have been passed.* This is not impossible in children with small, smooth, narrow calculi, and their sudden, strenuous micturition. (2) The stone may lie behind an enlarged prostate. Here the finger of an assistant passed into the rectum may help. (3) The stone may be enveloped in folds of mucous membrane. Injection of the bladder is here indicated. (4) The stone may be encysted. This is so rare as to have been called "the refuge of young lithotomists." The following case of Sir G. Humphry (*Some Cases of Operation*, pamphlet, 1856) shows well how embarrassing this condition may be :

A man, aged fifty-one, was cut, then submitted twice to lithotrity, then again cut in the old scar three times, all within six years, for an encysted calculus. On the fourth occasion of lateral lithotomy the nature of the case was made out accurately. The stone was now felt behind the prostate attached to the bladder by a pedicle which seemed to penetrate the coats of the viscus, and to be attached to another mass beyond it. It was evidently a stone of hour-glass shape, part being in the bladder and part in the sac. At each of the previous operations the part within the bladder had broken off, the rest not being extracted, owing to the size of the prostate. The symptoms recurring, urethro-rectal

* Cf. the case mentioned by Mr. Holmes, *Clin. Soc. Trans.*, vol. ii. p. 67.

lithotomy was performed. The stone being now within reach, the edge of the mucous membrane around it was incised with a hernia knife, and a stone, the size of a walnut, and with a truncated stalk, extracted. Death took place in two days, from pelvic cellulitis. Though the bladder was otherwise but little diseased the cyst seemed to have originated from the protrusion of mucous membrane between the muscular fibres, as another one existed, though without a stone. The cyst communicated by a considerable opening with the foul, infiltrated tissues. Sir George points out that these cysts may be quite out of reach in lateral lithotomy. As their walls consist only of cellular tissue, mucous membrane, and perhaps a thin layer of muscular fibre, they are easily lacerated during an operation, an accident almost certain to be fatal. The diagnosis is usually to be made if the stone is always struck by the sound at one spot, especially if, per rectum, a lump is detected corresponding to that spot.* The supra-pubic operation is indicated here, see footnote p. 993.

D. Entering the Bladder.—The time chosen for introducing the staff varies with different operators. Passing the staff while the patient is still recumbent is the easier; passing it when the patient is in lithotomy position is rather more difficult, but secures the operator against the risk of the staff slipping out after the patient is brought down into position, a risk which is greater with the straight staff. I prefer to bring the patient's lower limbs over the edge of the table, to pass the straight staff while he is thus recumbent, and then to have his limbs only brought up into position.

The nates just projecting over the edge of the table, the sacrum being flat upon it, the flexed thighs and legs being held well out of the way, the surgeon, seated comfortably, and with his face on a level with the perinæum, directs an assistant so to hold the staff as to bring the membranous urethra close to the surface of the perinæum. If a curved staff be used, this is easily done by inclining the handle strongly towards the abdomen. By this manœuvre, in Mr. Cadge's words (*loc. supra cit.*), the point of the staff "need not, and should not, be withdrawn from the bladder, but if it were it would be of no moment, because it would re-enter it the moment the handle is raised; the membranous urethra, instead of being almost perpendicular to the surface of the perinæum, as it is when the staff is held upright, is brought almost parallel with it, and is much easier to find with the knife; there is no inducement to open the urethra too far forwards, and consequently no risk of wounding the bulb or its artery. The staff gets a steady rest against the front of the pubes, and there is no danger to the rectum at this stage."†

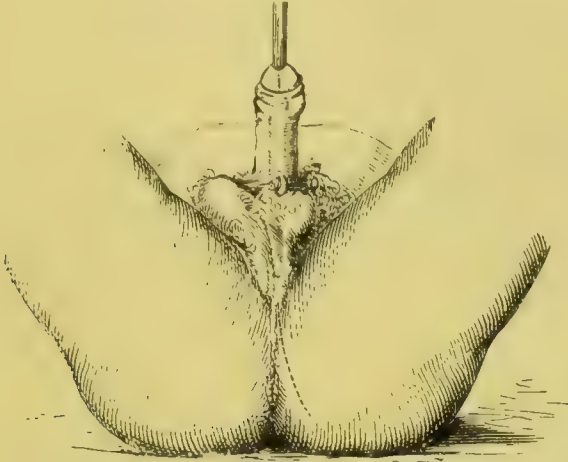
Having felt the staff thus presented towards him, having

* Sir J. E. Erichsen (*Surgery*, vol. ii. p. 945) adds that the beak cannot be made to pass round such a stone, so as to isolate it. To several other allied conditions of complicated stone, see the reference at p. 1006.

† It thus combines the advantages of the two very different methods usually given—viz., either to hold the staff well up firmly under the pubes and thus away from the bowel, but also away from the stone; or closely down upon the latter and in proximity to the rectum also.

examined into the depth of the ischio-rectal fossa, the site of the tuber and ramus ischii, the surgeon pressing up the junction of the scrotum and raphé so as to make tense the parts just about to be cut, enters his knife from $\frac{1}{4}$ to $1\frac{1}{2}$ inch from the anus, just

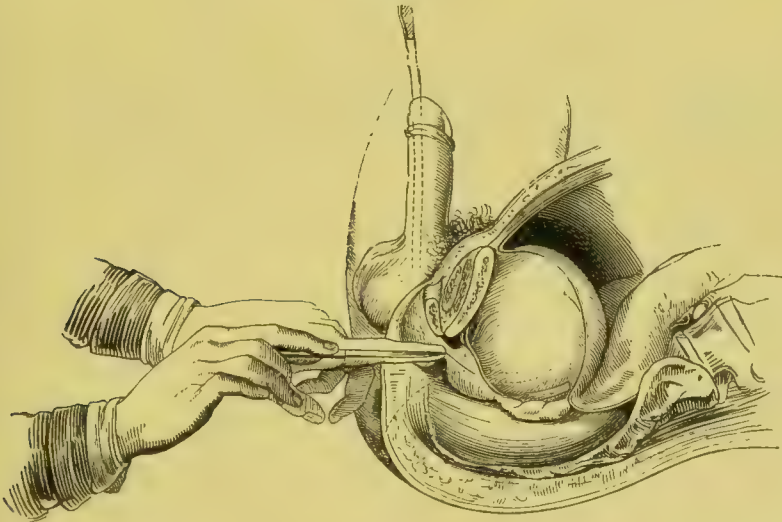
FIG. 270.



(Fergusson.)

to the left of the raphé, and very likely hits the groove at once. The knife is then drawn outwards and backwards with a rapid sawing movement, to a point midway between the anus and tuber ischii, thus making an incision of 2 or 3 inches, according to the age of the patient and size of the stone. Again inserting the

FIG. 271.



(Fergusson.)

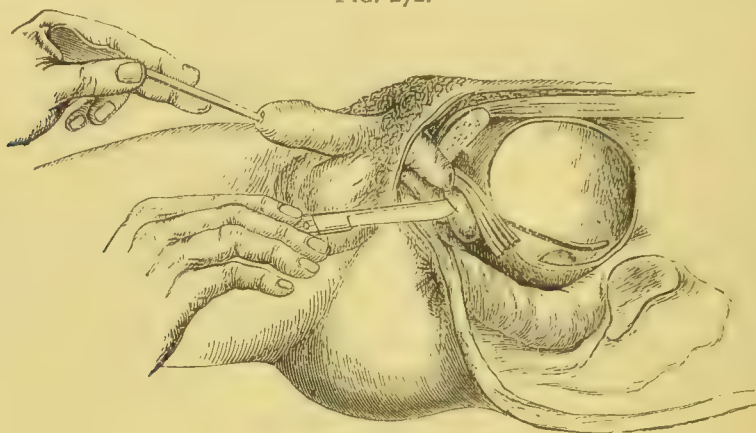
knife into the upper angle of the wound, the surgeon makes out exactly with his left index finger the groove in the staff, and exposes this, beyond doubt, in the wound. The next steps differ

somewhat, accordingly as the curved or straight staff is used—they will be given separately.

(a) **With the Curved Staff.**—When the knife's point is felt firmly lodged in the groove, its handle is a little depressed, the blade, at the same time, turned a little to the left, is pushed steadily along the groove till a gush of urine or a sense of resistance ceasing, or both together usually, announce that the neck of the bladder has been sufficiently divided with the knife. The finger is now wormed into the bladder over the concavity of the staff.

(b) **With the Straight Staff.**—When the point of the knife is felt to be safely lodged in the groove, the surgeon takes the handle of the straight staff from his assistant, brings it down, and still keeping his knife in the groove, lateralizes the staff slightly to the left, the handle of the knife being now depressed so as to

FIG. 272.



Lateral lithotomy with a straight staff. (Key.)

form a sufficient angle with it, and make an adequate wound, the surgeon runs it along the groove steadily, till he knows by the above given evidence that the neck of the bladder has been sufficiently cut.

The left index finger is next wormed over the edge of the staff, the straight staff being held by the surgeon himself, in his right hand, the curved one being held by an assistant, till he feels that he has entered the bladder and placed the finger tip, if possible, in contact with the stone. Entrance into the bladder is known by feeling the finger surrounded with a smooth cavity, lined with mucous membrane, while the finger itself is girt by a fibrous ring. The stone being felt, or the bladder cavity distinctly gained, the staff is withdrawn, and the surgeon, while taking his lithotomy forceps, dilates the opening into the bladder with his finger, which, at the same time, pulls down and steadies the neck.

Failure to Enter the Bladder.—This most vexatious and embarrassing difficulty is most likely to be met with under two widely different conditions—(1) most frequently, in little children; (2) in

old patients with a very fat, deep perinæum, and enlarged prostate. The first must be considered separately.

(1) *In Little Children.*—The causes here are, the small size, delicacy, and mobility of the neck of the bladder and urethra, and the fact that the bladder lies high up above the pelvis. Mr. Cadge quotes the following from Sir W. Fergusson :

"The point of the finger was, as usual, placed on the staff and pushed gently towards the bladder. The finger went on, but I was aware that it had not got between the urethra and the staff. With an insinuating movement (much to be appreciated by the lithotomist, who, as I do, professedly makes a small incision in this locality), I endeavoured to get its point, as usual, into the urethra and neck of the bladder. But here I felt convinced that I had failed, and was aware that the finger was getting deeper as regards the depth of the perinæum, but that I was not materially nearer the bladder. I could feel a considerable space at the point of the finger, and was convinced that the upper part of the membranous urethra, as well as the sides, had given way to the pressure, and that now, as the finger was getting deeper into the wound, I was only pushing the prostate and neck of the bladder inwards and upwards. These parts seemed to recede before the smallest imaginable force, whilst I felt that I could, in a manner, make any amount of space around the bare part of the staff. I had no difficulty in distinguishing between the surface of this space and that of the mucous membrane of the bladder. Moreover, I knew that I had never crossed that narrow neck which is always felt as the finger passes into the bladder when a limited incision is made. An impression came over me that I was about to fail in getting into the bladder, and I had an idea that, unless I could open the urethra in front of the prostate more freely, I should probably never reach the stone. This I effected with great caution, and then I could appreciate the passage of the finger as usual through the neck of the bladder. The stone was easily touched and removed, but I was forcibly impressed with the idea that I had nearly failed in the performance of the operation." The child here was four years old.

Mr. Cadge thus met the same difficulty in an infant of one year and a half :

"I felt the impossibility, even with a fair incision, of distending the wound with my finger ; it was like trying to get into the orifice of the urethra. I therefore desisted before doing any harm, and, taking a pair of common dressing-forceps, I passed them easily along the staff into the bladder ; by opening the blades gently but firmly, room was gained, and the finger entered and made room for small lithotomy-forceps. But I have repeatedly, after passing the dressing-forceps withdrawn the staff and removed the stone with them, and without introducing the finger at all."

Difficulties and Mistakes during this Stage of entering the Bladder.—This is so important a part of the operation that the following may be enumerated here :

1. Finding the staff. This is not likely to present difficulties in the case of a curved staff if it be held as advised at p. 986. Hitting a straight staff in a fat child is not always easy, owing to the small size which is needful. Attention must be paid to entering the knife at the root of the scrotum only just to the left of the raphé, when the finger-nail will detect the staff at once.
2. Not exposing the staff. Everything which lies over the staff in the upper angle of the wound must be clean cut. The tissues here, including the membranous urethra, are lax and delicate, and,

unless the knife is clearly in contact with metal, the groove will not be followed. 3. Losing the groove. This most serious accident may be due to not getting the knife cleanly into the groove, not keeping it sufficiently firmly in contact with it, and, thirdly, by forgetting to depress slightly the handle of the knife. 4. Cutting the prostate too freely as the knife is brought out. This can easily be avoided by keeping the knife sufficiently near to the staff. 5. Cutting into the rectum. This may be due to neglect of the following precautions: (1) Keeping the staff up away from the bowel; (2) guarding the bowel with the left forefinger in the wound; (3) when the knife is lateralized, cutting away from the gut. Mr. Cadge (*loc. supra cit.*) points out that the usual place of puncture is the dilated part just above the internal sphincter, and that this communication may be made secondarily by sloughing after extraction of a large stone, or after the use of a plug for arresting hæmorrhage. His experience is that "Nature seldom fails to bring about a cure, or so to contract the wound as to leave but trifling inconvenience." 6. Wounding the posterior wall of bladder.

Sir S. Wells, at the discussion of Sir H. Thompson's paper (*Med. Chir. Soc.*, April 2, 1878), mentioned a case in which Mr. Tyrrell wounded the back of the bladder, and hence always advocated a short knife. That this accident happened even in the hands of Aston Key himself, I know through the father of an old Guy's man who was present at the time.

E. Finding and Extracting the Stone.—The surgeon's left index finger, having passed into the bladder along the concavity of the staff,* finds the stone, hooks this down as near to the neck as possible, and at the same time steadies the neck while it dilates the incision in it and in the prostate. This combination of movements requires most careful attention to each of its details separately. The most important of these is the dilatation of the neck and prostate. If the stone is found to be a large one, the deep part of the wound must be sufficiently free. It is well known how much has been written on this matter. The surgeon should begin by dilating the neck of the bladder carefully and equally in every direction, using a considerable amount of force in an adult, but not throwing this on any limited portion of the wound. It may be accepted as a certain fact that the wound in the prostate may extend through the whole of this body, without risk of cellulitis, if only the recto-vesical capsule is not torn through. As long as the finger is girt by a fibrous ring this mischief has not been done. Whether an extensive wound in the prostate had better be made by dilatation and laceration or by free incision will probably never be settled. The wise surgeon will avail himself of a safe use of both—that is to say, after dilating with forcible but equal pressure all around the original wound in the neck, he will introduce a blunt-pointed narrow-bladed bistoury flat against

* This is only withdrawn when the stone is felt, not before.

the pulp of his finger, and nick the remaining constriction at one or two places, then dilating again.

Next to the size of the stone the age of the patient must, here, be considered. After middle life, the cellular tissue around the neck of the bladder is not only loose, but abounds in enlarged veins. Hence the risk of causing not only cellulitis, but septic phlebitis, by dilating an inadequate opening by the tearing, bruising exit of the stone, instead of by the finger and knife combined.

The deep opening having been thus made sufficiently free, the surgeon, having selected his forceps, introduces them along the finger (thus further dilating the wound), the latter being withdrawn as the forceps enter. These held at first in one hand (the thumb in the ring) are fully introduced closed, then opened widely transversely, and, by a quarter-turn of the handles, the lower blade is made to scoop or sweep along the floor of the bladder, which will almost surely catch the stone. If this step fail, it is repeated, and if the stone is still not caught, the surgeon feels again for the stone either with the closed forceps or by again inserting his finger, which will bring down the stone, push off projecting folds of mucous membrane, &c. Differently curved forceps, supra-pubic pressure, and a finger in the rectum, may all help now.

The stone being caught, the finger again feels if it is held in its shorter axis; if so, it may at once be extracted, if moderate in size, by steady deliberate traction downwards and outwards. As long as the stone advances all is well; if not, gentle rotation may again start it on its way. In less easy cases Mr. Cadge's words should be remembered: "Should there be much resistance and no sense of gradual yielding, the surgeon will ask himself whether this is due to an insufficient opening, or to the projection of the ends of an oval stone laterally beyond the bladder. This latter may be known by observing that the bladder is brought bodily down, so that the prostate, which is probably large, is visible near the external wound; in this case the stone must be liberated, the finger again introduced, and a fresh hold taken. If the obstruction is due to a large stone and too small a wound, the latter is to be enlarged in the direction of the first incision; this, in the opinion of the writer, is preferable to making the division of the neck of the bladder on the opposite side, and preferable, too, to using undue traction and force."

In some cases a scoop will facilitate extraction, the stone being firmly held between the pulp of the left index finger and the concavity of the scoop. In children one finger in the rectum and one in the bladder will often serve the purpose.

The stone being out, the bladder is carefully explored with the finger, or a short-beaked staff, aided by pressure above the pubes, or from within the bowel, for any other calculi or fragments. Multiple calculi will have been indicated by facets upon the first.

Any bleeding vessels are now secured, and the patient, wrapped up in blankets, is removed to bed.

Difficulties during the Stage of Extraction of the Stone.

(1) The position of the stone. This may be out of reach owing to its being at the posterior part of a dilated bladder, above the pubes, or to the patient having a very fat and deep perinæum. Pressure above the pubes, and the use of long forceps, are here indicated. (2) An enlarged prostate. This interferes with reaching the stone both with fingers and forceps. Curved forceps passed in along the staff, or a gorget, if the perinæum be very deep, will be helpful here, and perhaps a bag in the rectum would aid in raising up the stone within reach in difficult cases. An enlarged middle lobe of the prostate, or a separate adenoma of this gland, may also cause trouble by getting between the blades of the forceps. Tearing away of these portions of the gland has often occurred, and is sometimes certainly beneficial.* (3) Breaking up of the stone. This may occur with hard calculi from too much force being used with the forceps, but it much more often happens with soft phosphatic calculi. In such cases every fragment must be cleared out—a matter of some difficulty, as small ones are readily concealed in clots or folds of mucous membrane. After all the larger ones are picked out, a catheter of appropriate size, attached to a Higgenson's syringe, is inserted, and the bladder thoroughly and forcibly washed out with diluted Thompson's fluid (1 in 6 or 8, p. 995); or mercury perchloride 1 in 4000. In a week or ten days the bladder should again be carefully sounded, and examined with the finger, and any fragment extracted, this being especially needful if pain has persisted after the operation.† If fragments still persist a little later, an evacuating-tube and washing-bottle, aided if necessary by a flat-bladed lithotrite, must be employed. I may here express my belief that multiple calculi are not quite as rare as has been supposed. (4) Size and shape of the stone. Mr. Erichsen writes on this subject: "A calculus, about $1\frac{1}{2}$ inch in its shorter diameter, will be hard to extract through an incision of the ordinary length (not exceeding eight lines) in the prostate, even though this be considerably dilated by the pressure of the fingers; and I think it may be safely said that a calculus 2 inches and upwards in diameter can scarcely be removed by the ordinary lateral operation with any degree of force that it is safe to employ." Most will agree with Mr. Cadge that stones weighing upwards of 3 oz. will be dealt with by the improved supra-pubic method.

* It is doubtful if this is always so. Thus Mr. Cadge (*loc. supra cit.*) thinks "that it is probable that a careful examination of the subsequent condition of such patients would show that, although it may not have endangered life, it has not infrequently been followed by partial inability to retain urine. Prof. Gross (*Trans. Philad. Path. Soc.*, vol. iv. p. 153) thought that in one case the cavity left behind became a suppurating pouch, and increased the difficulty in micturition.

† Recurrence of stone within two years almost always means that a fragment has been left after the operation. No greater disappointment than this, both to the surgeon and patient, can happen. No one, probably, has cut fifty patients without having to admit and lament its occurrence, but it is especially liable to occur to the inexperienced" (Cadge).

SUPRA-PUBIC LITHOTOMY (Figs. 273 to 276).

Indications.—I may quote here from a paper which I read before the Royal Medico-Chirurgical Society (*Trans.*, vol. lxix. p. 377), and which concluded with the following propositions:

1. "That supra-pubic lithotomy, as recently modified, has a future of renewed usefulness before it, and that while, as an operation, it can never contrast with the rapid brilliancy of the lateral operation, it will be found of great value by those who only have to deal with stone occasionally, and by those who find themselves face to face with calculi of considerable size in adults.

2. That, to give other and more individual instances, the operation will be found useful in (*a*) many cases of hard stones of $1\frac{1}{2}$ inch in diameter; (*b*) in multiple hard stones; (*c*) in cases of calculus not phosphatic, occurring with enlarged prostate; (*d*) in some cases of foreign body in the bladder with abundant calculous deposit (Sir H. Thompson); (*e*) in cases of encysted stone.* In the rarer cases of (*f*) a state of urethra which will not admit the use of a lithotrite or a grooved staff; (*g*) in a very deep perinæum; (*h*) in a child with deformed pelvic outlet; (*i*) in a patient with ankylosed hip-joint not admitting of his being placed in the usual lateral lithotomy position (Sir H. Thompson).

3. That at present, till a larger number of cases of the improved operation have been collected, it will be wiser not to attempt to close the bladder with sutures.

4. That in reviving an abandoned operation these two questions call for an answer: (*a*) Do we stand in a better position towards the operation than our predecessors did? This question can only be answered in the affirmative, after the work done by Prof. Petersen and Sir H. Thompson. (*b*) On what grounds was the operation abandoned? The chief of these appear to have been, (1) The absence of any means of certainly avoiding the peritonæum; (2) the difficulty of sufficiently and painlessly distending the bladder in pre-anæsthetic days; (3) the absence of antiseptic fluids; (4) the fact that the operation was usually reserved for very large stones, and that it was often performed for such stones after lateral lithotomy had been attempted either on the same or the preceding day."

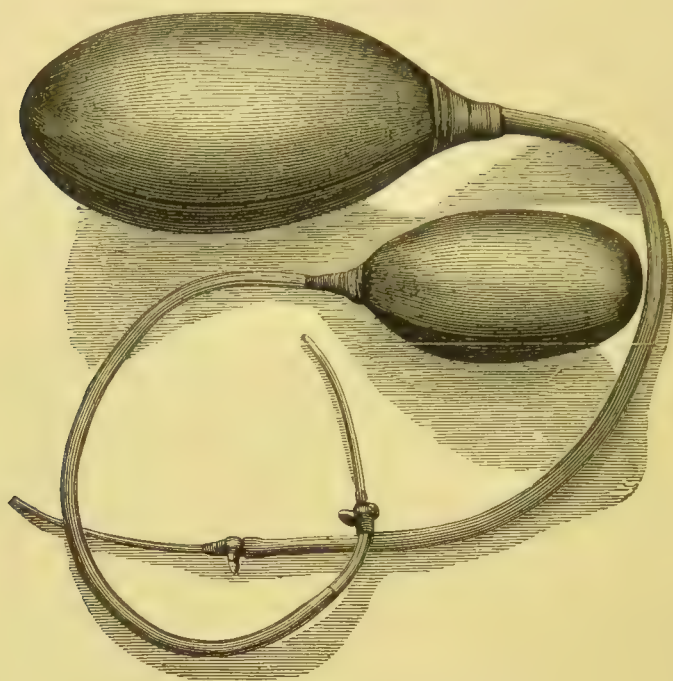
To the above remarks I would now add, speaking from a larger

* An interesting case of supra-pubic lithotomy performed successfully for an encysted stone by Dr. Corke of Baschurch (*Lancet*, 1889, vol. ii. p. 265), should be referred to. Mr. Bond, of Leicester, records another case (*ibid.* p. 260), in a patient aged sixty-one, who had been cut four months before, laterally, fourteen calculi being removed. At the second operation, a calculus was found embedded in the mucous membrane of the bladder, and removed successfully. But the cases which best illustrate the extraordinary difficulties which sacculated stones may offer, and how they may be successfully met by supra-pubic lithotomy, are two which Mr. Buckston Browne brought before the Clinical Society (*Brit. Med. Journ.*, 1890, vol. i. p. 239). In one of these, in addition to three calculi in a deep post-prostatic pouch, two stones were found in a vesical pouch which occupied the inguinal region.

experience, that the wound here is slower in closing; in fact, it may not heal firmly, as long as the urine may be alkaline. Occasionally it reopens, probably, as suggested by Petersen, from the *linea alba* uniting before the bladder.

The greater trouble and the longer time which this operation entails, both during its performance and afterwards, will not be grudged in these days, when it is so much the rule to pay attention to the details of surgery. Only time and a larger collection

FIG. 273.



Oval rectal bags, partly distended. A child's size is shown below.

of cases will show how far, with much simpler structures to cut, with these brought safely into reach, and with modern antiseptic details at hand in the after-treatment, this lithotomy is safer than the far more brilliant lateral one.

Details of the Operation.*

A. Distension of the Rectum.—The bag used for this must be (1) of sufficient strength; † and (2) of appropriate size. Thus, it should be of as soft rubber as is consistent with strength, with

* These are largely taken from a paper of mine (*Brit. Med. Journ.*, October 23 and 30, 1886).

† M. Guyon (*Ann. de Mal. des Organ. Génito-Urinair.*, t. i. p. 97) mentions a case in which the bag, being of thin india-rubber, did not support the bladder with sufficient firmness; the bladder, thus yielding to pressure, was difficult to open. Any additional handling of, or difficulty in opening, the bladder must increase the risk of cellulitis.

seams as little prominent as possible,* and flattened rather than pyriform in shape. (3) The amount of fluid. A flat† oval bag (Fig. 273), well coated with eucalyptus and vaseline, entirely emptied of air and folded up, is introduced well above the sphincters (the bowels having, of course, been well emptied). It is then carefully distended by means of an easily working syringe with water varying in amount from $2\frac{1}{2}$ to 3 oz. in a child of five, to 10 or 12 oz. in an adult. Sir H. Thompson gives the amount in the adult as 12 to 14 oz. I would advise operators to be content with the smaller amount of 8 or 10 oz., adding a little more later on, if needful, and only to use the larger amounts in special cases—*e.g.*, large stones, doubtful cases, or where a growth is present and it is desired to give extra elevation and steadying to the bladder.

A wider experience leads me to attach less importance to the use of the rectal bag. Efficient distension of the bladder will suffice by itself.

It is evident that with such large amounts as those recommended by some—*e.g.*, M. Guyon—serious risk is run of damaging the rectal mucous membrane. That this is no idle fear is proved by a case which came to the knowledge of Mr. Cadge, in which 15 oz. in the rectal bag caused a distinct tear of mucous membrane.

B. Distension of the Bladder.—The urine having been first drawn off, 8 or 10 oz.‡ of Thompson's fluid (borax, 1 pt., glycerine, 2 pts., water, 2 pts.), diluted 1 in 6, carbolic acid 1 in 80, mercury perchloride solution 1 in 4000, are gently thrown in by means of a syringe which works smoothly, and whose capacity is known. In children from two to five about 3 oz. will be sufficient. The patient should be well under the influence of the anæsthetic at this time, and if any straining takes place the injecting must be stopped, the hypogastric region supported with two hands, and some fluid allowed to run out if needful.

It may not be out of place to remark here that the surgeon

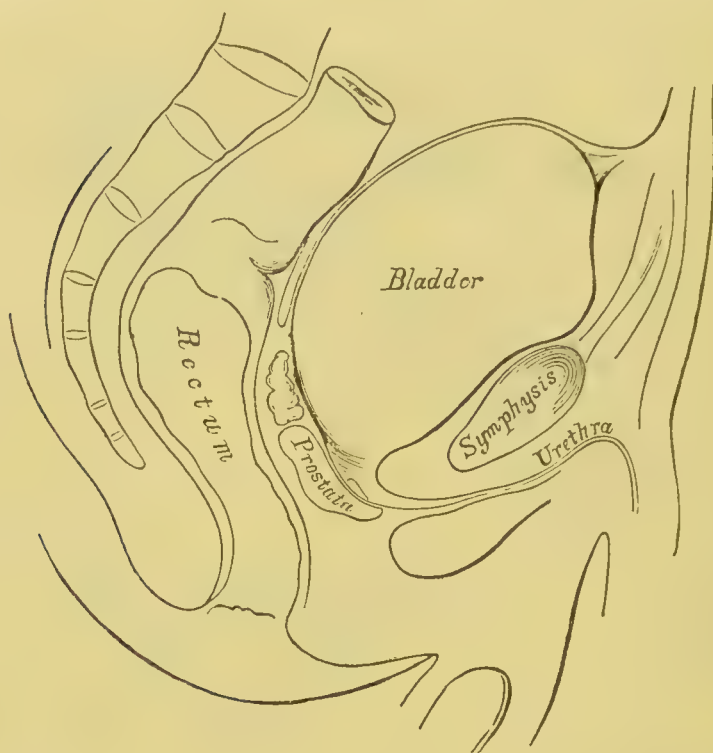
* In two of my earlier cases a little blood-stained mucus followed the withdrawal of the empty bag; no ill results ensued, and as this has not occurred in the later cases, I think it may be attributed to the use of the earlier bags of pyriform shape, stout rubber, and prominent seams. When a bag has not been obtainable the fingers of an assistant may be used instead.

† The pyriform bags tended to raise only the centre of the base of the bladder leaving two lateral sulci, in which it might be troublesome to find the stone.

‡ I strongly advise my younger readers to be content, in ordinary cases, with these smaller amounts. More can easily be added later on, when the bladder has become more used to the distension. In three cases (adults) out of my ten there was so much resistance with 8 oz. of fluid, that I had to stop injecting before I could distinctly feel the bladder above the pubes, yet on dividing the superficial structures the viscus proved sufficiently filled. In only one case, that of a rigid contracted bladder, have I failed to distend it at all. Here the supra-pubic opening was made on a curved staff successfully.

will do well, when injecting the rectum and bladder, to make sure that he is injecting fluids only. If he makes trial of the bag outside the body, he will see how easy it is to send in air as well as fluids, and thus to produce more distension than is intended, unless the bag is absolutely emptied first, and unless the syringe acts perfectly. By the double distension of rectum and bladder, the latter will, if not visible to the eye, be felt by the left hand,

FIG. 274.



Sagittal median frozen section through the pelvis of a young man, the bladder being distended. (C. Langer.)

of the surgeon (which should most carefully keep touch of the supra-pubic region), reaching about two-thirds of the way to the umbilicus.

In injecting the bladder, often irritable in these cases, the surgeon must keep careful count of its resistance. M. Guyon's (*loc. supra cit.*, p. 111) words should now be remembered: "On peut complètement supprimer la sensibilité au contact, mais jamais sa sensibilité à la distension."

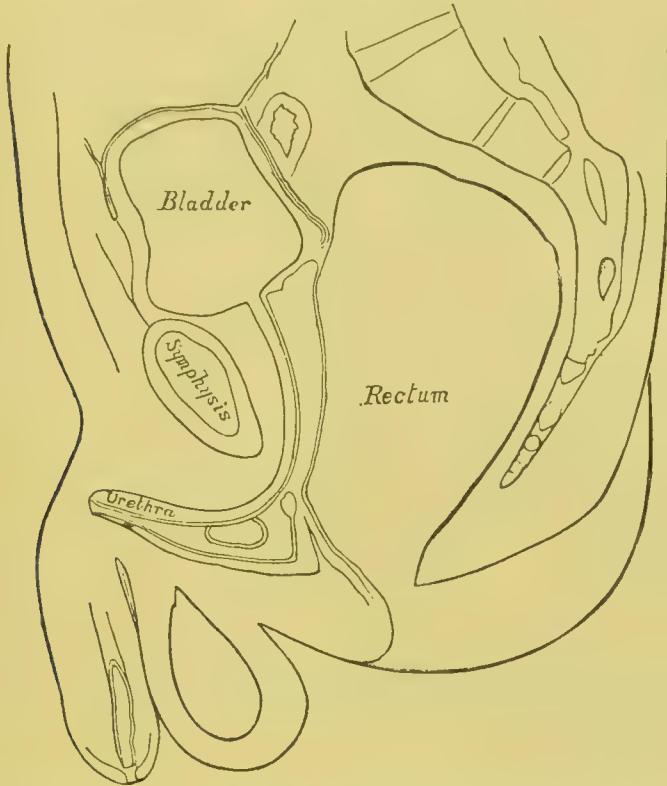
After withdrawal of the catheter, a Jaques' catheter or a drainage tube is tied round the penis to prevent the escape of the fluid. If the surgeon desire to retain a guide to cut upon, he should distend the bladder through a silver catheter, leave it in, and plug it.

In those cases of irritable bladder, where the contents are

ejected immediately a sound is introduced, attention must be paid, for a few days previous to the operation, to getting the bladder accustomed to gentle distension, steps which will also promote an antiseptic condition of the wound.

C. **The Operation Itself.**—The pubes having been shaved, the knees slightly flexed, and the shoulders a little raised, an incision is made about 3 inches long, exactly in the middle line and ending

FIG. 275.



Sagittal median frozen section of male pelvis, with distension of bladder and rectum. (Garson.)

over the upper border of the pubes. The subcutaneous fat, often plentiful in amount, having been divided, and any vessels secured with Spencer Wells' forceps, the linea alba is identified,* nicked, and slit up for 2 or 3 inches. The transversalis fascia is then picked up at the lower angle of the wound and divided. The retractors now drawing the edges of the wound well apart, a layer of loose tissue and of fat, often abundant, and frequently having

* If, instead of exactly hitting off the linea alba at once, the surgeon exposes fibres of a rectus or pyramidalis, he should go straight on through these with a director. Any prolonged search for the linea alba will leave frayed fibrous tissue, which will slough tediously, and become coated with phosphatic deposit if the urine be ammoniacal. If the muscles are thus torn through, it must be remembered that they lie on the fascia transversalis; there is no sheath behind them.

large veins in it, will next come into view, lying over and concealing the bladder. This must be torn through carefully and as cleanly as possible with the point of the director. Any veins which cross the wound (and a transverse branch lies often just opposite the site of puncture into the bladder) should be secured with forceps. If one is opened at this stage, the field of the operation will be obscured by most troublesome hæmorrhage.* This must be arrested by pressure-forceps, which act also as retractors, by sponge-pressure, or a very hot aseptic lotion—*e.g.*, hydr. perchl. 1 in 4000; prolonged manipulation in arresting hæmorrhage here may be the cause of that cellulitis later on which is so much to be deprecated. The anterior surface of the bladder will now be recognised by its pink colour, the fibres of the detrusor urinæ, and by its fluctuating under the finger. Veins often are met with again here on the bladder itself, longitudinal, transverse, and occasionally plexiform. Great care must be taken not to open up the fatty connective tissue which lies between the anterior surface of the bladder and the pubes. A spot on the anterior surface of the bladder having been chosen about $\frac{3}{4}$ inch † above the pubes, it is punctured (a hook being used if thought desirable), and the left index finger at once introduced to feel for the stone. The finger at the same time keeps the bladder hooked up, and prevents it settling back into the pelvis as the urine flows away. The stone is best removed by two fingers, or, if preferred, by forceps and scoop. The fingers, if successful, have the advantage of not risking any injury to the mucous membrane. Removal of the stone is not always easy; it falls back into the fundus, or into sulci on either side of the part raised by the bag. As soon as the calculus is removed and the bladder thoroughly explored, the fluid should be set running from the rectal bag, as emptying this takes some time.

The question now arises of closing the opening with sutures or leaving it open, in part at least.

The drainage of the bladder by a catheter in the urethra, or by suction and syphonage (p. 977) is so difficult, the patient's condition so very unsatisfactory‡ for the first week or so, owing to the

* M. Guyon in his second case met with most profuse hæmorrhage: "Nous essayâmes, mais assez vainement, a nous opposer a l'évalissement de toute la plaie par une nappe de sang sans cesse renouvelée." After repeated and fruitless attempts to arrest this hæmorrhage, the bladder was opened and the stone removed. The hæmorrhage ceased entirely on the removal of the rectal bag. The patient, aged sixty-nine, died with purulent infiltration of the sub-peritonæal connective tissue. Such severe hæmorrhage is very rare.

† The spot chosen must not be too low or infiltration may take place into the cavum Retzii behind the pubes; if too high, drainage will be interfered with and the peritonæum endangered.

‡ This is especially the case in elderly flabby patients with damaged kidneys, and unsatisfactory vital power and will. Such tend to become apathetic, to lie helplessly on their backs down in the bed, thus easily getting stasis in their

constant soakage in spite of voluminous dressings, that wherever it is possible the bladder opening should be closed by sutures.* A single row of Lembert's sutures put in efficiently (p. 827) will suffice. If a double row is used, the mucous membrane is first drawn together by a continuous suture of chromic gut, and then some interrupted sutures, not going deeper than the muscular coat.

Sutures should not be employed (1) where there is cystitis, and the urine ammoniacal, (2) where the bladder is irritable, thickened, and the better for drainage, (3) where the extraction is difficult and prolonged, and the parts necessarily bruised, (4) where there is any reason to expect bleeding; in such cases the clots will cause violent tenesmus, and, probably, giving way of the sutures, (5) where there is any stricture or an irritable condition of the urethra, sutures are inadmissible.

Where sutures are not used, in order to prevent extravasation, the cut edges of the bladder should be sutured with fine catgut to the fascial and deeper edges of the wound, two or three sutures being placed on either side, and one below at the lower end of the incision so as to shut off the tissues behind the pubes.

Two or three buried catgut sutures then draw the linea alba together above, the edges of this having been trimmed and pared, while three or four more unite the skin. Iodoform and collodion should be brushed over the united portion of the wound, and the

FIG. 276.



Supra-pubic lithotomy incision, seven days after the operation. Only the upper part of the wound was sutured.

lung bases and broncho-pneumonia, together with a low septic condition of the wound. The nursing of such cases is greatly helped by suture of the wound, and thus keeping the patients dry.

* One of the first to adopt this plan successfully was Dr. L. S. Pilcher of New York: a catheter was used till the ninth day, the patient, an adult, went out on the fourth, and on the fourteenth day was shown to the New York Medical Society, primary union having taken place throughout the whole extent of the wound, without unpleasant symptoms of any kind. Mr. R. W. Parker had an equally successful case in a child aged three. There have been several others. Mr. Anderson, of Nottingham, (*Lancet*, vol. i. 1890, p. 898), sutured the bladder in a boy aged ten. Acute pneumonia complicated the after-treatment, and on the night of the fourth day (the superficial sutures being removed and the wound healed) prolonged coughing tore open the wound. The case did well. Mr. Pollard described three cases in which the bladder was sutured after supra-pubic lithotomy in children. Urine leaked through in each case on the third day. All did well. In a very interesting paper by Mr. Bond of Leicester (*Lancet*, vol. ii. 1889, p. 260), it will be seen that in three out of four cases in which the bladder had been sutured, some urine escaped once about twelve hours after the operation. This did not delay the union.

bladder should be drained by Mr. Cathcart's method (p. 977). If this has not been provided, a large Thomson's supra-pubic tube should be inserted, and every attempt made by a regular supply of dry dressings, and, after the first twenty-four hours, turning the patient on his sides for a few hours alternately, to prevent any part becoming sore from the constant soaking. But if the bladder is not sutured, only some such method as Mr. Cathcart's will keep the parts dry and save the patient from the great risk of extravasation.* Where sutures are used it will be well not to unite the linea alba and skin below. For the first few days it will be unwise to trust to the patient's voluntary power of expulsion, and if the catheter becomes plugged, or if it is not passed just when required, some urine, possibly septic, may be forced out between the sutures before the bladder wound is finally closed, a process which must take two or three days. If this extravasation take place deep down in a wound like this, where the superficial parts have been closed, there is the gravest peril of a fatal issue from septic purulent infiltration of the connective tissue of the cavum Retzii, pelvis, and abdominal wall.

A few words may be said here about the *peritonæum*. With such distension of the bladder and rectum as has been advised, with an incision not begun too high up and carried well down over the pubes, with a moderate incision into the bladder, it is most unlikely that anything will be seen of the peritonæum. It may be very indistinctly felt at the upper part of the wound, but this is, usually, all.

If, after careful distension of the rectum and bladder the peritonæum still seems to encroach too far upon the anterior surface of the bladder, it may be pressed upwards and held out of the way by one or two fingers of an assistant, or, if needful, gently peeled upwards off the bladder with a steel director.† In elderly people with lax tissues and large stones requiring free incisions,

* The trochanteric and gluteal organs should be kept well smeared with eucalyptus ointment. If dry gauze dressings are kept in position by a many-tailed bandage, it only takes a few minutes to renew them. This will be necessary, at first, every three or four hours if the bladder is not sutured, and the surgeon who wishes to practise this operation successfully must be prepared to give much trouble and supervision to the after-treatment.

† In only three of my fourteen cases did I have any trouble with the peritonæum. To give one instance, in an elderly patient of Dr. Bell's, of Blackheath, with two lithic acid calculi each weighing 1 oz., the peritonæum almost reached the level of the symphysis. It was, however, easily detached from the bladder and held up with a retractor. I closed the upper part of the wound carefully over it, and sutured the edges of the bladder to the deep part of the wound. A good recovery followed in this and the other two cases which were similar. At the Congress of German Surgeons in 1886, Gussenbauer, Sonnenberg, and Kramer mentioned cases in which the peritonæum was found adherent to the symphysis. In one case it was opened with fatal results; in another, the opening was sewn up and the peritonæum safely separated from the pubes.

the peritonæum covered with its fatty tissue is more likely to be seen rising and falling in the upper angle of the wound.

If, what is most unlikely with the recent improvements in the operation, the peritonæum should be punctured before the bladder is opened, the puncture should be picked up and tied around with fine silk or chromic gut. If the opening is more than a puncture the cut edges of the peritonæum should be sutured to the edges of the external wound, and the bladder not opened for three or four days (Bruce Clarke, *Brit. Med. Journ.*, vol. i. 1890, p. 240).

If the opening is made after the bladder is opened, the surgeon must decide, according to the amount and character of the urine which has escaped, between suturing the opening and enlarging it upwards, so as to thoroughly sponge out or cleanse by irrigation with a 2 per cent. solution of boracic acid, the peritonæal cavity. But these accidents are most unlikely nowadays.

I have now operated by this method fourteen times in the last few years, the patients ranging from three to sixty-two years. Four only of the stones were large. Two were just over 2 oz., a third was 5 oz., in the fourth, a young woman, the stone, formed round a hair-pin, weighed 6 oz. In five they were multiple. In seven the urine was alkaline and foul. Four cases were fatal—the sixth, a lad of nineteen, an orphan, in wretched condition of body, and in much misery from pain. Perhaps I should have done more wisely to have waited longer, in order to feed him up before operating. His pain, however, was so severe that I operated a week after his admission into the hospital. He did excellently for forty-eight hours, then symptoms of pelvic cellulitis set in, proving fatal on the fourth day. The other case was one of multiple stones in a man of fifty-eight, much run down in strength. I removed eight calculi, composed chiefly of urates. The patient sank shortly after. His kidneys proved to be in an advanced stage of granular degeneration. Two other patients, elderly men, died of kidney failure, one on the fourth day, the other twenty-two days after the operation.

While on some points connected with the operation my mind remains open, I am strongly of opinion that, with carefulness, it is a safer operation than the lateral method for those who *only* perform lithotomy occasionally, and for large stones—*e.g.*, over 1 oz. I am certain that no benefit is to be gained by substituting it for the lateral in the case of children.

MEDIAN LITHOTOMY.

Disadvantages.

1. It gives very little room, and is unsuited to any save the smallest stones.
2. The wound being small, the surgeon cannot bury his knuckles in it or reach the bladder as easily as in the case of the larger lateral wound (Cadge).
3. The rectum on the one hand, and the bulb on the other, are in greater danger than by the lateral method (Cadge).
4. Troublesome bleeding is more frequent (Cadge).

Mr. Cadge, having operated on fifty or sixty cases by the median method, has given it up for the above reasons, and also because his mortality has been rather higher.

Advantages.—Recovery is often extremely rapid; the urine quickly resumes its natural route; and the wound, instead of gaping and healing slowly as the lateral wound does, heals almost by first intention.*

The above do not, however, compensate, in Mr. Cadge's opinion, for the disadvantages. He would avoid it, especially in children, in whom it is by some preferred, as in them a free incision is necessary to facilitate the passing of the finger into the bladder, while here the limit of space for the knife is very small indeed.

The operation is suited for prostatic calculi, but, if these are associated with any larger one in the bladder, the surgeon must either crush this before he can extract it through his small incision, or perform a supra-pubic operation.

Operation.—If a curved† staff be used, one with a wide groove is chosen, and passed and held with its handle inclined towards the umbilicus (p. 986), the patient being in lithotomy position. The surgeon passes his left forefinger into the rectum so as to steady with its tip the staff in the membranous urethra and also to guard the rectum from puncture, while at the same time note is taken of the depth of tissues between the knife and the finger. A straight and very sharp bistoury is then pushed, with its back downwards, through the skin, $\frac{1}{2}$ inch above the anus, straight on into the groove in the staff, which is now held well hooked up against the pubes. The knife, having distinctly exposed the groove, is pushed a little onwards so as to nick the apex of the prostate, and next, as it is withdrawn, it is carried upwards in the raphé so as to divide the soft parts for 1 inch or more according to the size of the stone. The finger would now be passed into the bladder, and the staff withdrawn. As, however, the staff occupies too much room in the limited wound to allow of this, a director is passed in along the groove, the staff withdrawn, and then the finger introduced along the director through the neck of the bladder. This is dilated sufficiently, and the scoop or forceps introduced.

Some surgeons prefer to make the incision from above downwards, but cutting from below upwards would seem better to protect the bowel.

If a straight staff be used, the surgeon, introducing his knife as above, and having cut upon the staff distinctly both to himself and the assistant who is

* Dr. W. T. Briggs, of Nashville (*Trans. Amer. Surg. Assoc.*, vol. v. p. 127), thus sums up the advantages of median lithotomy: (1) It opens up the shortest and most direct route to the bladder. (2) It divides parts of the least importance. (4) It is an almost bloodless operation. (4) It affords a passage for any calculus which can be safely extracted through the perinæum. (5) It affords the best passage for the fragmentation of unusually large calculi. (6) It reduces the death-rate to a minimum. In answer to the objection to the median operation that it is unfitted for the extraction of large stones, Dr. Briggs states that by making it a medio-bilateral operation (*vide infra*), as large stones can be removed by it as can be extracted by the lateral method. Since adopting the above modification, Dr. Briggs has had the following excellent results: Of the first seventy-four, none died. Then two died, but one of these had a pelvic abscess before the operation, and the other died at the end of three months with phthisis and the wound unhealed. Since then Dr. Briggs has had forty-six cases with one death.

† Mr. Erichsen recommends a rectangular staff, the angle of which rests against the apex of the prostate, and is thus much easier to find in the perinæum. This special staff is, however, often difficult to introduce, and a curved one, held so as to project its curve in the perinæum, will be easily found.

holding it, takes it into his left hand, and, having brought it down into an oblique position, runs his bistoury along the groove so as to nick the prostate; the enlargement of the wound and the rest of the operation are conducted as above.

Where the stone is too large to be extracted by the ordinary median operation, the **medio-bilateral modification** introduced by Gouley, 1828, and used so successfully in America by Dr. Briggs, should be employed. It consists in making, after a longitudinal incision in the raphé, a slight bilateral cut in the elastic ring at the neck of the bladder and the prostate.

Complications and Causes of Death after Lithotomy.—

1. Shock.—This is rarely severe, save in patients much pulled down, and after prolonged operations. Children as a rule, however reduced,* rally well after the operation (Sir J. Paget, *Clin. Essays*, p. 404). 2. Hæmorrhage.—If milder methods fail, this is best met by plugging the wound with the umbrella-plug, or by leaving *in situ* a pair of Spencer Wells' forceps, which will also aid the drainage. 3. Pelvic cellulitis.—This, the most frequent cause of death, is due either to extravasation of urine, probably septic, or to laceration of the deep parts, or both. It usually comes on within forty-eight hours. 4. Peritonitis.—Usually combined with the above. 5. Septic complications.—Septicæmia may occur early with pelvic cellulitis. Pyæmia, on the other hand, may come on later. 6. Surgical kidney. 7. Retention of urine.—Common enough, a few days after, from swelling of the parts. Rarely more serious. 8. Suppression of urine. 9. A sloughy, phosphatic state of the wound. 10. Sloughing of the rectum (p. 990). 11. Cystitis.—Rare. 12. Epididymitis. 13. Such causes as tetanus. Later complications, rare, but troublesome: 14. Fistula. 15. Incontinence. 16. Sterility.

LITHOTRITY—OPERATION WITH SEVERAL SITTINGS —RAPID OPERATION WITH ONE SITTING AND EVACUATION—LITHOLAPAXY.

Choice of Operation—Lithotritry or Lithotomy.—It is hoped that the following points, while they do not in the least exhaust the subject, will be found of practical assistance:

1. Amount of experience of the surgeon.—Every attempt should be made to become familiar with the use of the instruments, both outside the body and also by passing a lithotrite for examination of a calculus whenever one is felt on sounding. No surgeon who has not had abundant opportunities of practising the needful manipulations will do wisely in attempting to crush a hard stone which weighs an ounce.

* Occasionally, however, even nowadays, where the history is of long standing and the kidneys much impaired, they are too far gone for operation. See a case by Mr. Hutchinson (*Clin. Surg.*, pl. lxxvi. vol. ii. p. 126).

2. Size, kind, and number of stones.—As to size, up to 1 oz. or $1\frac{1}{2}$ oz., it is probable that, with the majority of stones, in fairly practised hands, lithotripsy is immensely superior to lithotomy as far as immediate mortality is concerned. I use the term “immediate” advisedly, because of the more frequent recurrence, with its results, after lithotripsy, and would refer my readers to the remarks on this point at p. 1007. With calculi from $1\frac{1}{2}$ to 3 oz., to quote Mr. Cadge’s words, “it yet remains to be seen whether lithotomy by any method can be applied with more safety and success than lithotripsy.”

The difficulty of a decision sometimes met with here is well expressed by the words of Sir W. Ferguson, that the greater is the experience of the surgeon the greater will sometimes be his doubt.

To any one with very limited experience rashly contemplating an attack upon a hard stone I would recall Mr. Milton’s words (*loc. infra cit.*): “During the first twenty minutes of a long crushing most men can maintain the necessary delicacy of manipulation, combined with the exercise of considerable force; but when it comes to working at the same strain for a second, third or fourth, or even fifth, sixth or seventh period condition begins to tell . . . this force has to be exerted with the greatest discrimination and the greatest patience.” In addition to the above must be remembered the frequent introduction and withdrawal of instruments, lithotrite and evacuators, and the result upon the neck of the bladder and the deep urethra.

Sir H. Thompson, speaking of hard calculi and litholapaxy (*R. C. S. Lect.*, 1884, p. 127), states that the largest he has dealt with weighed $2\frac{3}{4}$ oz., the operation lasting seventy minutes.*

More important than the size of the stone is its composition. There is, of course, no comparison between a pure lithic acid or oxalate of lime stone on the one hand and an alternating stone with a good deal of phosphate or urates in its composition, as a test of skill and endurance both on the part of the surgeon and his instruments. Dr. Hingston of Montreal (*Intern. Encycl. of Surg.*, vol. vi. p. 311), in his article on Lithotripsy, points out that sometimes the apparent softness of a stone is most misleading.

Having found an enormous stone in a patient, he employed lithotripsy, as the stone seemed soft. After getting away a large quantity of phosphatic matter, he was driven to perform lithotomy, and removed, by the lateral method, a calculus weighing over 5 oz., consisting mainly of oxalate of lime and uric acid.

There are several other *fallacies in gauging the size and number*

* Mr. H. Milton, “Lithotripsy, Simple and Complicated,” *Lancet*, April and May 1896, records an “epoch-marking case in which he crushed a stone (urates and phosphates) weighing over 12 oz. The operation lasted two hours, and an especial lithotrite with a gape of five inches was used. Such an operation is, of course, only possible for an expert with especial experience, such as Mr. Milton’s in Egypt. This surgeon had before (*St. Thos. Hosp. Reports*, 1891) referred to the extraordinary tolerance which Orientals show to all operations connected with the genito-urinary apparatus.

of calculi. Thus the lithotrite may again and again seize a stone which only weighs $\frac{1}{2}$ oz. in its long diameter, if flattened, of 2 inches. Testing by passing a staff around or rubbing it over a calculus is often most fallacious, and examining per rectum may, if the bladder be thickened, give evidence of a stone apparently much larger than it really is. Mr. Cadge (*loc. supra cit.*) points out a fallacy with regard to multiple stones. "When more than one stone is present, it is customary to seize one, fix it in the instrument, and proceed to sound afresh; this, however, may mislead, for a stone, having been grasped by the tips of the blades and moved about in the bladder, will sometimes rotate a little in the blades of the lithotrite and communicate a grating feel to the hand which is very like touching a second stone."

3. Condition of the urethra.—Two points have to be considered here—(a) how far will the urethra *admit* instruments—*i.e.*, how far is its canal normal or diminished by stricture; (b) how far, even if normal in calibre, will the urethra *tolerate* instruments. With regard to the first, a stricture, if admitting of dilatation, is not an obstacle to lithotritry; on the other hand, an old stricture with surrounding induration and fistulæ, or a less severe form which produces rigors and fever at each attempt of dilatation, are best submitted to lithotomy, which gives the best chance for the stone, and at the same time offers the much-needed relief of rest to the stricture. Mr. Cadge gives the following practical hint in these cases of stone combined with stricture: "Sometimes a stone is detected in the urethra behind the stricture, as well as one or more in the bladder, or it may be partly in the bladder and partly in the urethra, and in these cases median lithotomy will not only remove the stone, but may go far to remedy the stricture by external division."

With regard to an irritable urethra—*i.e.*, one without a stricture and only admitting instruments with the aid of anæsthetics—the chief points to consider are the size of the stone and the ability of the surgeon to deal with it by litholapaxy. If the calculus cannot be evacuated at once, or requires more than one sitting, lithotomy should be preferred, owing to the results of the passage of instruments and prolonged voiding of fragments.

4. Condition of the prostate.—An enlarged prostate is of great importance, not only from its power of obstructing the operation, but from the changes which it brings about in the bladder. Thus, it interferes with the efficient use of instruments, the picking up of a stone even with the blades reversed, and the finding of the last fragment. Again, the use of the lithotrite and the passage of evacuating tubes readily lead to hæmorrhage, and this again by clots prevents the free and easy use of the evacuator. Later on, phosphatic deposit, imperfect evacuation, residual urine, and recurrence of stone symptoms are all frequent accompaniments of enlarged prostate.

5. Condition of the bladder.—Formerly it was held needful to

operate with several ounces of fluid in the bladder, and some suggested to draw off the urine and inject 8 or 10 oz. of fluid. This amount has now been reduced to something more like 4 or 6 oz. As, if the urine is healthy, no fluid is more suited to the bladder, the surgeon should content himself with following Sir H. Thompson, and "ask the patient to retain his urine for a little less than his accustomed period before the sitting; that is, if he is naturally able to retain his urine for about an hour, he is requested to pass it forty minutes before the time of the visit."

Some other changes * in the bladder require mention. (a) Sacculation pouches or sacs, whether mere hollows behind or at the sides of an enlarged prostate, or hernial protrusion of the mucous membrane between the muscular fibres, may be the starting-point of calculus by entangling débris or tiny fragments. In Mr. Cadge's words: "The imprisoned fragment first fills up the cyst, then, by continual accretion of phosphates, it grows up into the bladder like a mushroom, and is probably again and again nibbled off by the lithotrite, each time with temporary benefit, until the patient dies, worn out with chronic cystitis and pyelitis." Mr. Cadge goes on to say: "By turning the aperture of the evacuating catheter towards these pouches, and by the free use of the aspirator in all directions, the fragments may be washed out of them and all removed, but it cannot be denied that it is always a serious matter to shatter a stone into innumerable fragments in a bladder of this description." (b) Atony, whether with or without an enlarged prostate. The importance of this is obvious, as tending to recurrence of stone by some small fragments not being expelled in spite of the vigorous use of the aspirator, and also to cystitis from imperfect emptying of the bladder.

6. Condition of the kidneys.—Here I may again quote a veteran's opinion, that of Mr. Cadge: "What is to be said of stone complicated with kidney disease, such as albuminuria and chronic pyelitis and atrophy? In these cases all operations are fraught with danger, but it is probable that the least danger will be met with from a carefully conducted one-sitting lithotrity. So, too, in those cases of constitutional disease combined with stone, such as diabetes, tabes, and other spine disease, it will be well to avoid the shock and hæmorrhage of lithotomy, and proceed, if any surgical proceeding is allowable, by lithotrity." The surgeon, in considering an operation in any of the above diseases, will weigh

* Several allied conditions exist in which the position of the stone is complicated with difficulties—*e.g.*, (1) where the stone has been partly in the bladder and partly in the urethra. (2) The stone has been lodged entirely or partly in a diverticulum of the bladder. (3) The stone has been lodged in a deep pouch behind the prostate; and (4) the stone has been partly in the bladder and partly in the urethra. For helpful information on these and many other points I would advise my readers to consult Mr. H. Milton's paper on "Lithotrity in Cases of Stone, Simple and Complicated," *Lancet*, April and May 1896.

well the size of the stone, his ability to cope with it at one sitting, and the amount of suffering which it causes the patient.

7. Age.—Here, especially, age is not to be reckoned by years alone.

Recurrence.—As no one, to my knowledge, has spoken out on this subject with such helpful candour as Mr. Cadge, with his experience of 300 cases of stone, I make no apology for quoting once more from his writings (*Brit. Med. Journ.*, July 3, 1886): “Although the immediate and direct mortality of lithotritry is small, the recurrence of stone is lamentably frequent. In my own list of 133 cases, there were 18 in which recurrence, one or more times, took place, being about 1 in 7. Sir H. Thompson, with a much larger number of cases, gives about the same proportion. I am disposed to infer, however, that recurrence is more frequent even than this, because it is not likely that all who get relapse apply to the same surgeon again. Living, as I do, in a local centre, and drawing cases chiefly from a limited area, I am probably more able to trace, and more called on to treat those who suffer a second and third time, than he who lives in the metropolis and draws his cases from great distances. Patients may, and frequently do, apply to the same operator once or twice; but, after a time, they either apply to their own surgeon, or they decline further treatment, and too often their subsequent history is one of painful endurance of chronic bladder disease and gradual exhaustion. If, moreover, there be added to the list those numerous cases of phosphatic deposit or concretions so frequently noticed after lithotritry, the relapses would, I believe, reach to nearly 20 per cent. This seems a heavy indictment to bring against lithotritry, but I am afraid there is no gainsaying it; and, if so, it would be wrong to pass it over or make light of it. Many of these relapses might be prevented if the patients would observe directions and persevere with treatment. It certainly is so with the unenlightened and uncomplaining hospital patient. Feeling himself well, or what he considers well, he goes to his work, and neglects the use of the catheter and other means; and, instead of returning in a month or so to have his cure certified, or a minute remaining fragment removed, he toils away as long as he can, and returns, perhaps in a year or two, with a fresh uric-acid stone, or with chronic cystitis and a phosphatic one. The educated, sensitive, private patient, on the other hand, will watch his symptoms narrowly, and return if the slightest indication of the old mischief should reappear. . . . This frequent recurrence must be due either (1) to the descent of a fresh stone from the kidneys, or (2) to a fragment of stone having been left at the first operation. As to the descent of a fresh stone: there can, of course, be no doubt as to the occasional occurrence of this cause, just as we see it occur after lithotomy. The bladder being entirely cleared of stone, there will be the same liability to the descent of a fresh renal calculus after one operation

as after the other. What then, let me ask, is the fact as to lithotomy? I have already shown that there were only 21 cases out of more than 1000 of lithotomy at the Norwich Hospital in which recurrence was clearly traced to perfectly fresh formations coming, like the first, from the kidney, or about 1 in 50; whereas, in Sir H. Thompson's list of about 600 persons treated by lithotrity, he mentions 61 cases in which he operated twice, 9 three times, 3 four times, and 2 five times—75 in all, or about 1 in 8. The inference from these data seems to me to be inevitable that relapse of stone after lithotrity is chiefly due to other causes than the descent of a fresh stone. To my thinking the majority of recurrences is caused by the great difficulty in ensuring the complete removal of all the débris; I have already referred to this in old persons with enlarged prostates and feeble atonic bladders, and it is this class of patients who are especially liable to relapse." Mr. Cadge goes on to show that the tendency to phosphatic deposit after lithotrity is not due to vesical incompetence and residual urine alone without some overlooked fragment, and that the improved method with repeated washings will still fail to discover a last fragment in some bladders.

Operation (Fig. 279). — The preparatory treatment has been much simplified. It is now recognised that the best course is to remove the stone: previous passage of sounds, and injections of the bladder,* are now but little used. A few days' rest, bland unirritating liquid diet, mild aperients, and securing sleep are the chief indications.

The instruments required will be gathered from the following account: The patient having been anæsthetised and lying on a firm couch or mattress close to the right side of the bed or table, with his pelvis raised, and body and limbs well protected from chill, the surgeon, standing on the right side with his instruments close to him, introduces his lithotrite. In doing this care must be taken not to get the blades hitched either just in front of the triangular ligament or in the roof of the prostatic urethra. This will be secured by not depressing the instrument till very late—in fact, not till it is just about to enter the bladder. The instrument, well warmed and oiled, is held at first horizontally over the groin or abdomen, the penis being drawn over it, the shaft being all the time gradually brought into the vertical position as the instrument finds its way by its own weight into the bulbous, membranous, and prostatic urethra. Now, and not before, the handle is somewhat depressed, and the instrument glides quickly into the cavity of the bladder. If the prostatic urethra is enlarged and lengthened, the surgeon may think that he has reached the bladder, but the fact that the gentlest lateral movement of the lithotrite is interfered with will show him his

* The amount of urine to be held, in most cases, has already been mentioned (p. 1006).

mistake. Pressure with the instrument is alone allowable at the meatus; some rotation may be called for in guiding the instrument through the triangular ligament or past an enlarged prostate. In this latter case also the handles must be further depressed, and a finger in the rectum may give help.

When the lithotrite has entered the bladder it should be allowed to slide, very gently, down the trigone, being now held very lightly so as at once to detect the site of the stone, which it now often touches, but must not displace.

If the stone is felt on one side, the instrument is gently turned to the opposite one, opened, and then turned towards the stone. If it be not felt, the handle of the instrument being slightly raised, and the blades very gently depressed and then opened, the stone will often drop into them.

If this fail, the instrument is turned, open, first obliquely, then more horizontally, first to the one side, then to the other. In the event of the stone still eluding the lithotrite, which is most unlikely, it should be sought for with blades depressed. To effect this, the blades, closed, are raised off the bladder floor by depression of the handle, carefully reversed, and then depressed again so as to sweep lightly over the floor. They are then gently opened and closed, vertically first and then obliquely, so as to complete the examination.

During the above, the following points must ever be borne in mind:

(a) The handle and shaft of the lithotrite are to be kept as steady as possible, so as not to jar the sensitive neck of the bladder needlessly. (b) All movements are to be executed at or beyond the centre of the vesical cavity, the proper area of operating, without hurry, rapid movement,* or any other which partakes of the nature of a jerk or concussion (Sir H. Thompson, *loc. supra cit.*, p. 296). (c) The male blade is never to be brought into contact with the neck of the bladder, unless this is rendered necessary by the position of the stone.

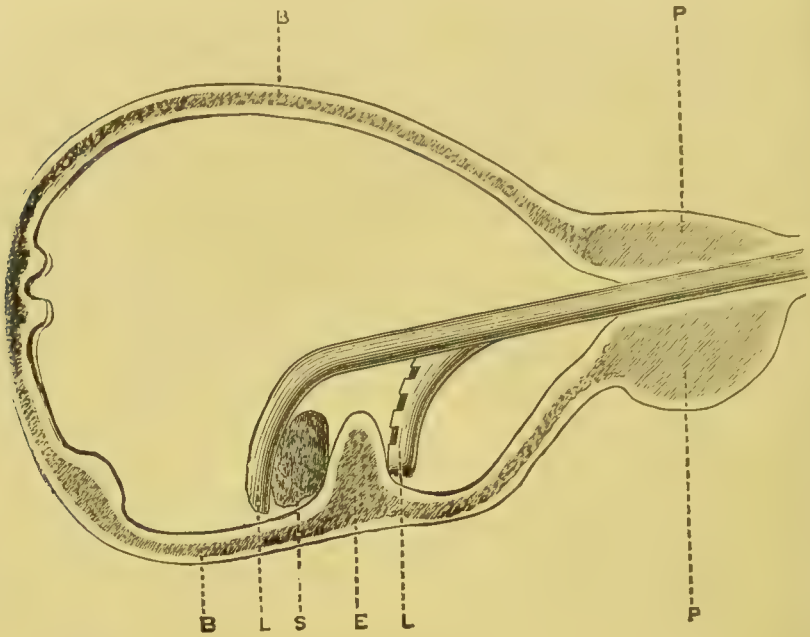
The stone being seized by one of the above manœuvres, the button† moved, and the screw connected—the screw is gradually turned at first to make the jaws bite, since a sharp turn at this time may drive the stone out either to right or left—the calculus is then carried to the centre of the cavity, which will show whether a fold of mucous membrane has been seized (Fig. 277). As the screw is applied more and more forcibly, one or other of the following will be noticed. If not well caught, and if hard, the

* "Rapid movements produce currents which keep the stone more or less in motion, so that it is less easily seized than when the surrounding fluid is in a state of rest" (Thompson).

† In this respect Prof. Bigelow's lithotrite seems inferior to Sir H. Thompson's, the working of the button in the latter being smoother and less vibrating.

stone will be pushed out of the jaws; if hard and well gripped, it is felt to split into fragments; if soft, and held, it crumbles down. If extremely hard, as a pure lithic acid or oxalate, any attempt at advancing the screw is met by this distinctly recoiling instead of advancing. Each surgeon must now decide for himself, according to his knowledge of his instruments and reliance on his power to deal with large, hard fragments, whether to continue or at once to perform lithotomy. If he continue, the resistance will be felt

FIG. 277.



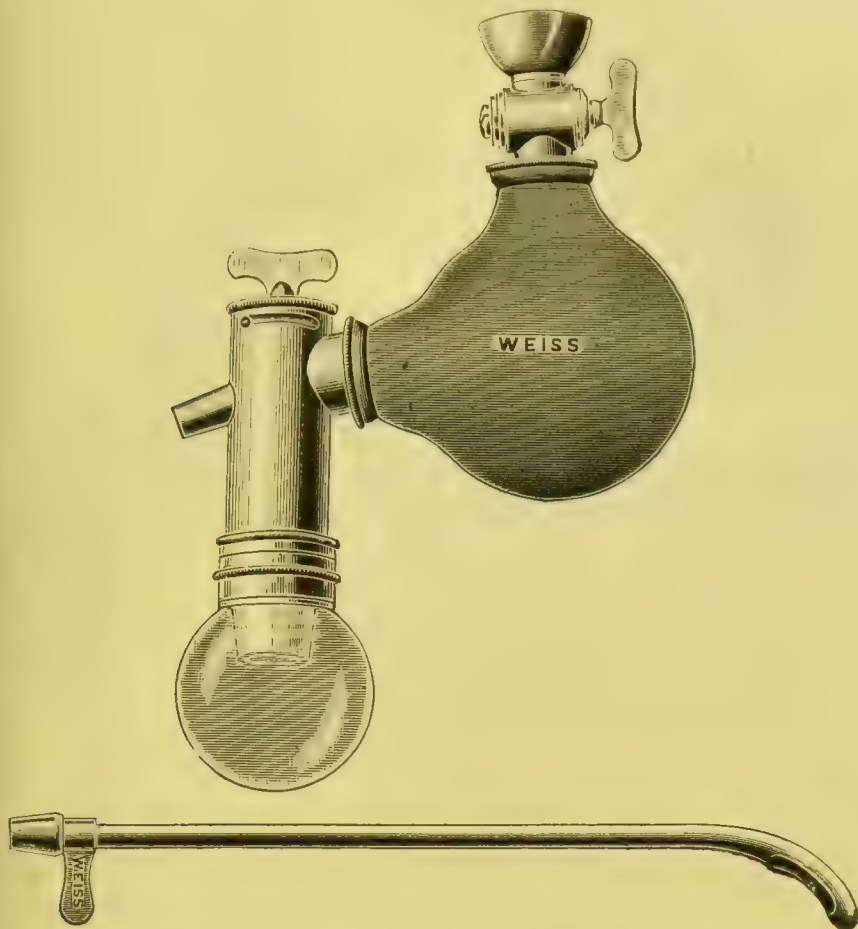
This shows a risk present in operating in trabeculated bladders. While the female blade (L) is in direct contact with the stone (S), the male is in contact with a ridge of the mucous membrane (E). B. Bladder. P. Prostate. (R. Harrison.)

to give way, in the case of a very hard stone, by a sudden sharp crack; in one less hard, more gradually. In overcoming much resistance the surgeon either screws up the male blade as hard as he can and keeps it so, or, having gently unscrewed it a little, screws it up again with a series of light jerks so as to communicate blows to the stone. Cracking of the stone having taken place, the fragments will usually fall close to the original site. Thus the lithotrite has only to be kept as immovable as possible to ensure, on drawing out and again closing the male blade, the seizure of a fragment.* This is crushed, and the process repeated again and again till sufficient débris is formed. The lithotrite is then withdrawn firmly screwed up.

* It is not always easy to distinguish between a piece of soft stone enveloped in inspissated mucus and the lining membrane of the bladder.

An evacuating straight or curved * tube, No. 16 for a stone of moderate size, and 18 for a large one, is then introduced, the

FIG. 278.



Sir H. Thompson's aspirator, last pattern but one. (Freyer.)†

evacuator, filled ‡ with a warm solution of boracic acid or dilute Thompson's fluid (p. 995), is connected, the meatus being first incised with a narrow probe-pointed bistoury downwards by the

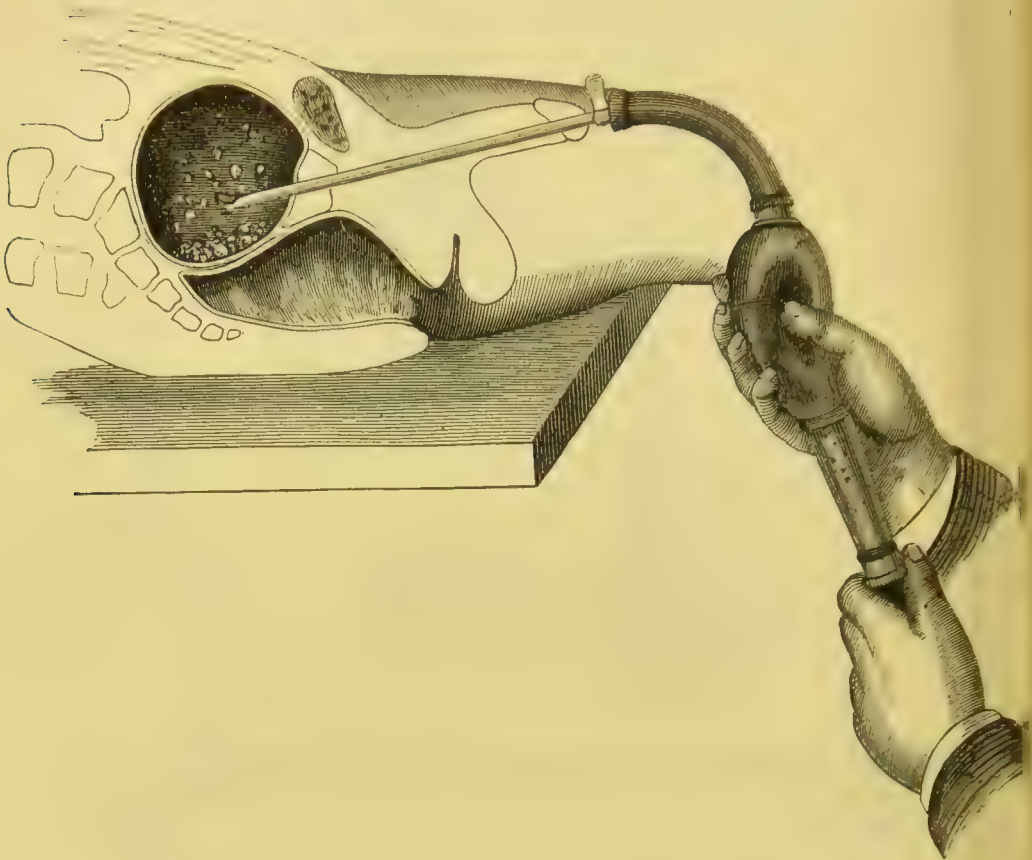
* The tube, if curved, should be held downwards at first, but not quite on the bladder floor; then to one side or the other; then upwards, washings being carried on at the time that these movements are made. A straight tube should lie with its orifice just within the neck of the bladder.

† Of this instrument Dr. Freyer writes (*Litholapaxy*, p. 25): "I must confess a great liking for Thompson's instrument. One of this variety made for me by Messrs. Weiss I have worked with for four years, and though it has assisted at 130 operations, and been through three hot weathers in the plains of India, it is still as efficient as much newer instruments I possess, a fact which speaks well for the india-rubber employed in its construction."

‡ Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 244) gives this precaution as to getting rid of air entirely: "The urine, having trickled away through the tube, leaves the latter full of air, an element fatal to nicety of washing. This

side of the frænum, if needful. While his left hand supports the evacuator, with his right the surgeon gently but quickly squeezes the bag with sufficient force to send in about 2 oz. of fluid. On relaxing the pressure an outward current takes place, bringing with it crushed fragments. Sir H. Thompson recommends that, after the

FIG. 279.*



The operator is here supposed to be sitting between the thighs of the patient. The expansion of the compressed bulb will aspirate a part of the abundant débris suspended in the fluid. The fragments, being too abundant, have been dispersed. (Bigelow.)

bag has expanded and the current apparently ceased, the surgeon should wait a few seconds, "as at that precise time it is quite common for one or two of the larger fragments to drop into the receiver which would have been driven back, perhaps, by too rapidly resuming the pressure."

air may be disposed of most simply. The tube is withdrawn until its eye is in the prostatic sinus, the washing-bottle is attached, and the stop-cock turned, but no further suction made. In an instant, the air contained in the tube is heard ascending through the stop-cock and mounting into the top of the evacuator, where it does no harm, and whence it cannot possibly return into the bladder."

* The above evacuator is now old-fashioned. Mr. Golding Bird's pattern, or the one figured at p. 1011, will be found the most handy.

If, after several washings, the outflow stops, and the bag no longer expands, the end of the evacuator is blocked either by a fragment of stone, or a small calculus, a clot of blood, or the mucous membrane of the bladder. If it be a fragment, as is usually the case, or a clot, dislodgment may be effected by sending in quickly a gush of fluid, or by the use of a gum-elastic stylet, after unscrewing the tube. Impact of the bladder generally takes place when a curved evacuator is turned upwards, and when the bladder is empty. The sensation given may be a kind of flap, simulating the click of a fragment; more often it is a dull, vibrating thud, easily recognised. More fluid must be at once injected.

If a large fragment is felt striking against the tube, or if the surgeon is certain that several good-sized fragments remain, he removes the tube and evacuator, and, while an assistant withdraws the blood-stained fluid and fragments and re-charges the evacuator, he introduces a small lithotrite and crushes up sufficient débris to go on again with the washings.

All the time the surgeon must keep before his eyes a mental picture of the interior of the bladder, perhaps diseased, the ureters, perhaps dilated, leading up to kidney pelves enlarged, and remember that the effects of any squeeze of his hands are felt, not only all over the bladder, but perhaps in the ureters and kidneys as well.

Detection and Seizure of the Last Fragment.—This is, as is well known, a matter of much difficulty, owing to the facility with which small fragments get hidden in some folds of mucous membrane or enveloped in blood-clot. As long as there is any “clicking” against the tube, the surgeon must persevere in his attempts at complete removal. If, after several washings, nothing comes out into the receiver, the surgeon should listen carefully over the bladder, as thus advised by Dr. Keyes: * “The tube is turned in various positions, and the operator listens. The swash of the water as it rushes in and out is heard with startling distinctness, and, if the management of the tube is skilful, any fragment of stone lying loose in the bladder is sure in a short time to be driven against the metallic tube so as to announce its presence by a characteristic click, quite distinct from that emitted by the flapping of the bladder wall against the eye of the instrument. Fine sand and thin scales of stone make no sharp click, and all such may be left to pass by nature’s efforts, but any piece large enough to require the lithotrite can hardly escape detection by the educated ear.”

Time occupied in Litholapaxy.—This may be, on an average, from half an hour to an hour and a half. Prof. Bigelow (*Amer. Journ. Med. Sci.*, January 1878) operated continuously for upwards of three hours, removing 744 grains, the patient making a good

* *Loc. supra cit.*, p. 246. The whole of this account, with its vigorous life-like language, will well repay perusal.

recovery. Mr. R. Harrison (*Brit. Med. Journ.*, August 10, 1882) removed a $2\frac{1}{2}$ oz. stone in two hours and ten minutes.

The Old and the New Operation of Lithotritry briefly contrasted.—Old lithotritry advocated short sittings, and brief use of instruments, and left the expulsion of fragments, &c., as much as possible to nature. It probably requires less skill, and, in Mr. Cadge's words, "is gentler, milder, less formidable altogether; no anæsthetic is probably required; no extra assistance. . . . A nervous, timid patient may prefer this to the more heroic and rougher, if more expeditious, method." It might be added that it is less tiring to the surgeon. But these advantages are trifling as compared with its disadvantages, which are done away with by the new operation, of which the chief are the prolonged passage of fragments, often rough and angular, along a bruised urethra. Mr. Milton (*loc. supra cit.*) has invented an evacuating lithotrite—a combination of the usual crushing and evacuating instruments, which will be useful in the aged, with a moderate sized and soft stone, and enlarged prostate, from the single introduction required.

The new method of litholapaxy, introduced by Prof. Bigelow, resulted from, and was led up to by, several achievements of modern surgery. Without anæsthetics, without the knowledge of the large instruments admitted by the urethra, without the pitch of perfection and power to which modern instruments have been brought, litholapaxy would still be an impossibility. Owing to its brilliant success, and the rapidity with which it relieves the patient, the single-sitting method has practically rendered the other obsolete.

After-treatment.—The chief points here are: rest in bed, the patient turning on his side to pass water, for the first few days; hot fomentations to the abdomen, and hot bottles at first; morphia subcutaneously, if indicated; warm milk, barley-water, mineral waters or lemonade, a little whisky or brandy being given, if needful: all chills should be carefully avoided. Mr. Milton (*loc. supra cit.*) recommends salicylate of soda at first every two and then every four hours if there is fever, and diuretin if there is diminution of urine. In each case the amount given is one gramme.

In addition to the above, the putting the patient frequently in hot hip-baths for a quarter of an hour, the occasional passage of a soft catheter, and the rendering the urine alkaline, will give much relief. The urine should always be strained through muslin to collect the débris.

Complications during Lithotritry and Litholapaxy.

1. **Escape of Urine.**—This may take place during or after the passage of the lithotrite. The penis should be compressed against the lithotrite, and a pause made while the patient is got more fully under the anæsthetic. If this fail, tying a tape round the penis and instrument, injecting a little fluid, or putting off the operation till the bladder is in a more fitting state after the use of instru-

ments, injections, and such drugs as belladonna and subcutaneous injections of morphia, may be made use of. 2. *Hæmorrhage*.—Sufficient blood to stain the fluid in the evacuator during the operation, and the urine for a day or two after it, is not uncommon. If the hæmorrhage during the operation is severe, the surgeon must decide whether it is due to the damage to the bladder or urethra, to his having scratched the latter by withdrawing a fragment in the evacuator's eye, to bruising of an enlarged prostate, or to co-existent growth. In this last case the suprapubic operation will probably have to be performed either at the time or later; in the other cases the surgeon must decide on completing or deferring the crushing by the amount he has already effected, his experience, and the amount of the bruising inflicted. 3. *Clogging or Fracture of the Lithotrite*.—Clogging or impaction is liable to happen with a non-fenestrated instrument with weak and narrow blades. With one properly made, with as broad blades as possible, and the male one blunt, roughened, and laterally bevelled off, the accident is unlikely. When it occurs, it must be met by percussing the instrument, if opening and closing the blades, and thus freeing them in the fluid, is impossible. If the impaction persist, the blades must be withdrawn as far as possible by safely maintained traction. If no force that is wise will withdraw them, they should be cut upon in the perinæum, thrust out, unloaded, and withdrawn, and the rest of the stone removed as by a median lithotomy. If, owing to any defect in the instrument, the blades, though not clogged, cannot be screwed up, they must be cut upon as above, thrust through, and, if possible, filed off. If a blade break off, it must either be caught and withdrawn by another lithotrite, or the patient cut at once. 4. *Injury to the Bladder or Urethra*.

Complications after Litholapaxy and Lithotrity.—These are much the same as those already given at p. 1003, as occurring after lithotomy.* The chief differences are the greater liability to rigors and urinary fever, and the greater frequency of epididymitis. Bruising of the urethra has also to be remembered, whether by the instruments, or, after the old-fashioned lithotrity, by the passage of fragments.

LITHOLAPAXY IN MALE CHILDREN.

The advisability of this mode of treating stone has been strongly advocated by Surgeon-Major Keegan,† who, after a wide experience of large stones in India, is inclined to think that the objections usually made to litholapaxy in boys are not valid. Thus: (1) as to the *smallness of the bladder*, the bladder of a boy of even only three or four is, as a rule, quite roomy enough to permit of the efficient

* The same want of space that caused me to treat these, above, too briefly, prevents me going into them again here.

† *Litholapaxy in Male Children and Male Adults* (Churchill, 1887); *Lancet*, 1886.

working of a small lithotrite and a medium or full-sized aspirator if gently worked. The bladders of boys with stones are, as a rule, healthy, and will stand more distension proportionately to their capacity than the bladders of old men. (2) *The extreme sensitiveness of the mucous membrane of the bladder and urethra.* Dr. Keegan thinks that, with an anæsthetic, this may be safely disregarded. (3) *The liability to laceration of the mucous membrane of the bladder and urethra.* This objection is, he thinks, a theoretical one only. (4) *The small calibre of the urethra.* Dr. Keegan states that not only is the calibre of the urethra in boys of six or eight not very small, but that of boys of only three or four is sometimes very large. As in men, the true calibre of the urethra cannot be told unless the meatus, which is sometimes very small, is incised. Speaking generally, the urethra of a boy from three to six will admit a No. 7 or a No. 8 lithotrite (Eng. scale), and that of a boy of eight or ten will admit a No. 10, a No. 11, and even sometimes a No. 14. "With a No. 8 lithotrite and a No. 8 evacuating catheter it is, I find, quite feasible to dispose of a mulberry calculus weighing between two and three hundred grains in an hour's time.*

Dr. Keegan insists upon the completely fenestrated lithotrite as being the only perfectly safe instrument to use, as, with any other, clogging of the blades is a very likely and a most dangerous complication.

In discussing, in the first edition of this book, the advisability of surgeons adopting, as a general rule, this method of dealing with stone in male children, I pointed out (1) that one very important matter, the percentage of recurrence after litholapaxy at this age, had been left undealt with by Dr. Keegan; and (2) that such an individual experience, splendid as it is, can scarcely be taken to furnish a rule to those who only meet with stone at comparatively rare intervals. Dr. Keegan has since written on both these points (*Ind. Med. Gazette*, Feb. 1890, p. 40).† It will be seen that, with regard to the first point, the fact that recurrence after litholapaxy in boys in India is so very small, is due to the opportunities and experience, absolutely unrivalled and never to be known in this country, which fall to the lot of surgeons in India, in treating stone in the bladder. With regard to my second point, that such an individual experience, so different to anything that we meet with here, should not mislead those who only meet with stone at comparatively rare intervals to substitute litholapaxy for the eminently safe operation‡ which lateral lithotomy has been proved to be in boys, Dr. Keegan writing as follows confirms my opinion: "I am disposed to

* Dr. Keegan has had constructed by Messrs. Weiss a lithotrite, No. 6 in the stem and in the angle, which will readily pass through the urethra of the great majority of boys of between two and three, and is perfectly capable of disposing of stones weighing up to 2 drachms. A rather larger one is No. 6 in the stem and No. 8 in the angle. Dr. Keegan advises any one wishing to give litholapaxy in boys a fair trial, to provide himself with a set of completely fenestrated lithotrites running from No. 6 to No. 10 (Eng. scale).

† Dr. Keegan in a letter of later date says that his litholapaxies in boys now amount to 125, with only four deaths. In three of these extensive disorganisation of the kidneys was proved to exist. In the fourth there were strong reasons for suspecting it.

‡ Mr. Bryant, in writing of the successes which lateral lithotomy has given in children (*Surgery*, vol. ii. p. 106) states that during seventeen years 100 patients had been cut consecutively at Guy's without a death. Another matter deserves mention. Cutting for stone is no longer limited, as of old, to a few great centres. How many institutions in or out of London, how many cottage hospitals, will be provided with the set of special instruments which are necessary?

agree with Mr. Jacobson in doubting if in Great Britain lithotomy in male children will be replaced by litholapaxy. And why? Because to render himself familiar with the use of the lithotrite, the surgeon must be afforded frequent opportunities of dealing with cases of stone; and as such opportunities occur only at rare intervals to the majority of hospital surgeons in Great Britain, they will therefore very naturally cling to that operation which is performed by aid of the instrument with which they are most familiar, the scalpel."

Owing to the increasing rareness of calculus in children at the present time, and the fact that, as a rule, isolated cases—and only successful ones—are alone published, it is very difficult to speak definitely about the results of litholapaxy in children in European surgery. I would call the attention of my readers to a paper by Alexandrow (*Deut. Zeit. f. Chir.*, 1891, Bd. xxxii. Hft. 5, S. 6). This surgeon performed lithotripsy thirty-two times in boys between one and fourteen years of age in a children's hospital at Moscow. In twenty-seven the operation was successful; the remainder were fatal, and in three death occurred from injury to the urethra during the operation. Mr. E. Owen, with praiseworthy candour, brought a case before the Medical Society (*Lancet*, vol. i. 1891, p. 665), in which fatal rupture of the bladder had taken place during litholapaxy in a boy aged four.

TREATMENT OF STONE IN THE BLADDER IN THE FEMALE.

Practical Points.—The absence of any prostate or of a fixed smooth trigone-surface is of importance here, especially with regard to lithotripsy. The aid given by a finger in the vagina, the dilatability of the urethra, the association of calculi with foreign bodies, are also well known. It is only occasionally that enlargement of the uterus or prolapse of the vaginal wall of the bladder interferes with the treatment of stone.

Operations.

A. In Adults.—We have here the following three methods to consider:

1. **Dilatation.**—When the stone is small—i.e., the size of a filbert, a stone not exceeding $\frac{3}{4}$ inch in its largest diameter—it may be safely removed by rapid dilatation with Weiss's instrument guarded with fine drainage-tube,* followed by a finger (the little one first).

* So as to avoid the risk of splitting the soft parts. It is not meant by the above remarks that much larger stones have not been successfully passed and removed from the female bladder. Thus, Dr. Yelloly (*Med. Chir. Trans.*, vol. vi. p. 574) gives a case in which a stone, weighing 3 oz. $3\frac{1}{2}$ drs., was extracted: incontinence followed. Where large calculi—e.g., of 6 oz.—have come away spontaneously, it has been usually by a process of prolapsus and ulceration combined. We do not yet know what is the greatest dilatation which the female urethra will safely bear. Perhaps the limit given above is, if anything, too small. Erichsen (*Surgery*, vol. ii. p. 1024) gives "8 or 10 lines in diameter" as the size of a stone which can be safely extracted by this means. Sir H. Thompson (*Syst. of Surg.* vol. iii. p. 308) says, "dilatation should never be employed for any calculus larger than a small nut or a large bean in an adult, which limits its application to very

2. **Litholapaxy.**—By this means calculus in the female bladder may be most frequently and efficiently treated. Thus, hard stones under an ounce, and phosphatic ones of a much larger size, may be dealt with at one sitting. The character of the ring or sound with the staff, the bite of the lithotrite, and the condition of the urine will aid here. A shorter instrument will be found much more convenient to work with. Where there is much irritability of the bladder, much difficulty will be met with in keeping fluid in it, owing to the absence of a prostate and the shortness and directness of the urethra. The pelvis must be well elevated, the patient placed fully under the anæsthetic, and the finger of an assistant should make pressure on the urethra. In other respects the operation resembles that already fully given for the male (p. 1008). The dilatable urethra admits a full-size evacuating tube.

3. **Lithotomy.**—This operation is called for when the stones are multiple, when one is large, especially if mainly hard as well, when there is a foreign body as a nucleus,† when there is great irritability with ulceration of the bladder, or when a growth co-exists.

Of the following methods—(a) vaginal, (b) supra-pubic, (c) urethral, and (d) the lateral method of Buchanan—the first two only need be alluded to.

Vaginal Lithotomy.—By this is meant extraction of a stone through an incision in the anterior vaginal wall, behind the vesical orifice of the urethra, and thus not interfering with this canal at all.

This anterior wall is about 4 inches long in the adult; in relation with it anteriorly is the urethra, to be felt as a cord through this wall, behind this the bladder, and farther back the os and cervix uteri. No peritonæum is normally in relation with this wall, as this membrane leaves the uterus half-way down to pass directly on to the bladder. No important vessels or nerves are met with in vaginal lithotomy; but this, though the simplest and easiest of all the methods of cutting for stone, will be but rarely called for, as in all moderate stones in women, litholapaxy is usually available, while in the case of larger ones, and with all calculi in female children, the supra-pubic method is indicated, save for tiny stones which can be removed after dilatation. The only drawback of a vaginal lithotomy in women is the risk of a fistula, but this need only be taken into account where phosphatic urine is present, or where the edges of the wound

few cases." Mr. Bryant (*Surgery*, vol. ii. p. 120) states that, "in children, a stone $\frac{3}{4}$ inch in diameter, and in adults 1 inch, may be fearlessly removed from the bladder by rapid dilatation and extraction, with the patient under the influence of chloroform. I have removed larger calculi, 2 inches in diameter, by this means, without any injurious after-effect, but it is probably not wise to make the attempt, the surgeon possessing in lithotritry an efficient aid or substitute." Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 297) recommends not dilating the urethra more than $\frac{3}{4}$ inch.

* As in Dr. Galabin's case (*Obst. Soc. Trans.*, April 7, 1880), in which twelve large calculi and about fifty smaller ones were removed successfully by vaginal lithotomy from the bladder of a woman aged sixty-one.

† As in the large stone formed round a hair-pin, and figured (p. 579) by Hart and Barbour in their *Manual of Gynecology*. Here the projection of the hair-pin on either side of the stone would indicate, nowadays, the supra-pubic operation. I have alluded to a similar case in my practice at p. 1001. Some of my readers may remember that three years ago an inquest was held in London on the body of a girl who died with an undetected calculus in the bladder, which dated to a hair-pin. The sarcastic remarks of the coroner led to some correspondence in the papers, from which it would appear that these calculi are less rare than has been believed.

have been bruised during the extraction of the stone. In either case the calculus will probably be a large one or multiple, a condition, as already stated, which is better dealt with otherwise. The following case, which came under my care in 1889, is a good instance of how the operation may be occasionally called for: "Vaginal Lithotomy in a Patient 6½ Months Pregnant; Immediate Suture of the Wound—Recovery; Normal Delivery at Full Time" (*Lancet*, vol. i. 1889, p. 628). A. L., aged twenty-seven, was sent to me by Dr. Montagu Day of Harlow, December 7, 1888. For three years she had had bladder trouble—viz., hypogastric pain, cystitis, very frequent micturition day and night, with stoppages of the stream, and acute suffering after the bladder was emptied. The patient was extremely timid and nervous, owing to her four confinements having been "tight" and lingering. Craniotomy had been required with the first, and with another labour was induced at seven months.—December 8. The urethra was dilated, and the bladder explored. A calculus, apparently an inch in either diameter, was felt; the bladder was extremely contracted, with its mucous membrane in places raw and bleeding, in others encrusted with phosphates. It was decided, for the reasons given below (1020), to perform vaginal lithotomy.—December 10. Twenty-four hours after the exploration the patient had recovered control over her bladder. The vagina was thoroughly syringed out with hydr. perch. (1 to 1000), the posterior wall was well drawn down with a duckbill speculum. A straight lithotomy staff (No. 4) was then passed, and the site of the stone determined. A sharp hook was next inserted into the posterior part of the urethra so as to drag the anterior wall of the vagina upwards and forwards. This, however, caused such free oozing that it had to be removed, and sponge-pressure applied. The bleeding was partly caused by the vascularity of the parts due to pregnancy, and partly by that set up by the dilatation of the urethra two days before. A sharp-pointed bistoury, introduced so as to avoid the urethra and neck of the bladder, was carried into the groove of the staff through the anterior wall of the vagina and fundus of the bladder, and then backwards for nearly 2 inches. The gush of urine which at once followed on the withdrawal of the knife carried the stone downwards, and it was extracted with lithotomy forceps with the utmost ease. After the bladder had been explored with the finger, it was repeatedly washed out from the wound* with diluted Thompson's fluid. Little bleeding had followed on the incision, and it was clear that sutures would entirely control what remained. The vagina having been well sponged out, the edges of the incision, clean cut and without bruising,† were adjusted with six salmon-gut sutures and four of horsehair. The apposition was tested with a fine probe, especially behind, where a little difficulty was met with in inserting the sutures. Owing to the patient's straining at this time, some urine escaped from the urethra, but none came through the wound. The vagina was next thoroughly syringed with a solution of hydr. perch. (1 in 3000), dried out with aseptic sponges, and dusted with iodoform. To secure more certain asepsis, and also to support the wound and sutures, the vagina was lightly plugged with strips of iodoform gauze. Though this was done with all gentleness, it was soon after noticed that blood was trickling from the vagina. On removal of the strips, two small lacerations on the right side of the vagina, near the orifice, the parts here being exceedingly pulpy and vascular, were oozing freely. This was arrested by tying up the bleeding points with chromic gut. The vagina was again irrigated and insufflated, but no further trial of plugging was made. As soon as the patient was replaced in bed, a soft catheter was inserted to empty into a "slipper." The recovery was rapid and without drawbacks. The ten sutures

* It would be wiser to do this from the urethra.

† Under less favourable conditions closing the wound may have to be deferred till the parts are quite healthy.

were removed on the eighth day with the aid of chloroform. The catheter was retained till the twelfth day, when the patient was allowed to get on a sofa. She left the hospital seventeen days after the operation. Dr. Day wrote, on March 19, that the patient had been safely confined without any trouble with the lithotomy incision. The first question to decide here was whether to operate at once or to let the pregnancy (already advanced to six months and a half) be first concluded. While the stone itself was not large enough to have interfered with labour, both Dr. Day and I thought that, if the bladder were allowed to remain in its present state for another two months and a half, the cystitis would be rendered much more difficult of treatment, intensified, as it was likely to be, by a lingering and difficult confinement, such as the patient was liable to. It having been decided that it was advisable to interfere at once, the choice lay between (1) *dilatation of the urethra*, (2) *litholapaxy*, and (3) *lithotomy*. (1) *Dilatation*.—The size of the stone at once put this aside. Though small (240 gr.), it was a full inch in one diameter, and just over $\frac{3}{4}$ inch in the other. With such a stone (a hard one, of lithic acid and lithates, there was a very serious risk of after-incontinence (especially when the blades of a small forceps have to be taken into consideration as well). (2) *Litholapaxy*.—If it had not been for the co-existing pregnancy, the stone might well have been thus dealt with. But as great irritability of the bladder was present in addition to the pregnancy, it was thought that litholapaxy was more likely to require a prolonged anæsthetic and to cause greater disturbance of some important pelvic and abdominal viscera than the remarkably simple and rapid vaginal lithotomy. It will be remembered that the way in which the anæsthetic would be taken, and its after-results, were more than ever matters of uncertainty in this case. If the anæsthetic had been badly taken, we had to face the risks, on the one hand, of premature labour coming on, and, on the other, of difficulty in completing the operation, and thus of fragments being left behind, which would intensify the already existing cystitis. (3) *Lithotomy*.—It being decided to resort to this, the vaginal method was chosen from its great simplicity, the small amount of anæsthetic required, and the facilities which it gave for washing out the bladder at the time of the operation.

Supra-pubic Lithotomy.—This has been fully described at p. 993. The fluid is retained in the bladder by finger-pressure upon the orifice of the urethra.

B. *In Children*.—Some of the conclusions which Mr. Walsham has drawn in a very helpful paper (*St. Barthol. Hosp. Reports*, vol. xi. p. 129) may be quoted here:

For small stones rapid dilatation under chloroform is better, as causing less annoyance and inconvenience to the patient. That moderate- and even large-sized stones have been removed by dilatation, but that, as incontinence has frequently followed from over-distension, it is not justifiable to subject the patient to this risk. That, after limited dilatation, should the stone appear larger than was anticipated, it may be crushed with safety; but, should crushing be considered unadvisable or impossible, it is better to perform vaginal lithotomy than subject the patient to any risk of incontinence by over-dilatation. That it is not safe to aid the dilatation by incising the urethral walls. That incision of the urethra alone, without dilatation, in whatever direction practised, is frequently attended with incontinence, and should therefore be abandoned. That moderate and even large stones can be easily removed from young children by vaginal lithotomy, aided, if necessary, by dilatation of the vagina, incision of the fourchette, and crushing of the stone by the wound made through the septum, without any risk of a permanent vesico-vaginal fistula so long as the edges of the incision are not bruised in the extraction.

Mr. Walsham considers each of the above and several other points separately, and supports them with evidence. I think that this tends to show, in the case

of vaginal lithotomy, that, though a stone may be thus extracted after dilatation of the vagina, division of the fourchette, and destruction of the hymen, it is by no means easy in these cases to insert sutures satisfactorily. It will be wiser, I think, to make use of the supra-pubic operation in female children for all save the very smallest stones. Lithotrity is by no means easy in these small bladders, and the risk of vesico-vaginal fistula has already been shown to be very great.

I would refer my readers to a case of supra-pubic operation by Mr. Barwell in a child, aged nine, from whom a stone weighing $2\frac{1}{2}$ oz. was successfully removed. It is interesting to note that Mr. Barwell was led to adopt the supra-pubic operation from his having had within seven months no less than three cases of vesico-vaginal fistulae originating in the extraction of calculi during infancy and youth by different surgeons (*Med. Chir. Trans.*, vol. lxi. p. 342).

CYSTOTOMY.

Indications.—The operation of opening the bladder, apart from such cases as exploring for growth, foreign body, &c., may be required in:

1. Some cases of cystitis. When the urine is fetid and slimy. When pain in the bladder and penis is intense, leading to loss of sleep and appetite. When there is a high temperature and other evidence of imminent septicæmia. When all other treatment has failed, and when washing out is insufficient or unendurable.

The operation here, for the sake of the kidneys, must not be put off too late. Much benefit may be obtained by irrigating the bladder freely, and afterwards mopping it out with a small sponge and a solution of silver nitrate, \mathfrak{Z}_{ss} or \mathfrak{Z}_{j} — \mathfrak{Z}_{j} .

2. Some cases of great irritability of the bladder persisting after dilatation of a stricture. Mr. R. Harrison (*Surg. Dis. of the Urin. Org.*, p. 201) believes that the continuance of the irritability in these cases is due to the muscular hypertrophy which the bladder has undergone in its constant endeavours to force urine through the obstruction in front of it, and that the cystotomy is curative by bringing about atrophy or loss of that muscularity.

3. Some cases of tubercular cystitis (p. 979).

4. As part of other operations. Thus, in plastic operations about the urethra, to keep the parts dry, the bladder may be opened. I have done this in a case of epispadias.

5. As this operation will not again be alluded to, I may remind my readers that cystotomy, or, rather, opening the prostatic urethra on a staff, has been recommended by Sir H. Thompson (*Dis. of the Prostate*, p. 176) in those few but most distressing cases of enlarged prostate leading to hourly catheterism, cystitis, loss of sleep, and other aggravated symptoms.

6. Supra-pubic cystotomy is employed occasionally in Hunter's

method of treating stricture by passing a sound from the bladder up to the perinæum.

Supra-pubic cystotomy for drainage of the bladder. A helpful account of this method is given by Mr. Bond (*Lancet*, vol. ii. 1889, p. 260). The distended bladder having been incised above the pubes in the ordinary way, the urethral orifice is felt for with the forefinger, and a curved staff passed until it bulges in the perinæum just below the bulb. The patient being placed in lithotomy position, the point of the staff is cut down upon, pushed through, and a rubber tube attached to it. This tube, with one or two openings in it, is drawn through above the pubes. In a few days it may be drawn into the bladder from below, and a little later withdrawn altogether.

Where the supra-pubic and perinæal incisions have been made, use of for a stricture which cannot be dilated from the front, the curved sound is removed as soon as the perinæum has been opened, and the stricture thoroughly divided. A grooved director is then passed from the perinæum into the bladder, and, upon this, as a guide, a full-sized catheter is passed from the urethra into the bladder and tied in. See a case of traumatic stricture thus treated by Mr. Howse (*Clin. Soc. Trans.*, vol. xii. p. 9).

The above are instances of cases calling for cystotomy. The surgeon will have to choose between three operations—viz., median and supra-pubic cystotomy and external urethrotomy. The median operation is almost always to be preferred to the lateral, but it is probable that external urethrotomy (pp. 1001, 1030) will be sufficient in most cases as to drainage, and it is certain that this operation is less risky from shock, cellulitis, and secondary hæmorrhage. The great object is to drain the cavity thoroughly.

RUPTURED BLADDER.

The treatment of this hitherto most fatal injury has of late years been cleared up.* Exploratory operations and suture of the bladder will be increasingly successful in favourable cases—i.e., those seen early and those in which the injury is limited to the bladder.

Two forms of rupture are recognised—the intra- and extra-peritonæal. It may be well to state, succinctly, the symptoms.

Intra-peritonæal Rupture.—(1) History of a likely injury. (2) Inability to pass water.† This power has, however, been preserved in both varieties: naturally it is seen most frequently and more completely in extra-peritonæal cases. It is

* Especially by Sir W. Mac Cormac's paper, with two successful cases, *Lancet*, 1886, vol. ii. p. 118. Many others have followed. Mr. Walsham has been able to report two successful cases (*Trans. Med. Chir. Soc.*, 1886 and 1895.)

† Thus the rent may be valvular or blocked by intestine, &c. On all these and many other points the reader should refer to Mr. Rivington's writings, *Dict. of Surg.*, vol. i. p. 152, and *Rupture of the Urinary Bladder*, for exhaustive completeness and helpful information.

very rarely normal in the intra-peritoneal ruptures. (3) A little bloody urine drawn off with a catheter. (4) Difficulty of manipulating an instrument in a contracted bladder. (5) If the catheter, hitting off the rent, be passed beyond the bladder, a much larger quantity of blood-stained fluid is withdrawn, partly urine, partly serum, from irritation of the peritonæum.* (6) Speedy (usually) supervention of peritonitis. (7) Perhaps fluctuation and dulness in the flanks.

Extra-peritoneal Rupture.—(1) History of a likely injury. (2) Inability to pass water (*vide supra*). (3) A little bloody urine drawn off. (4) The catheter finds the bladder contracted. (5) No tapping of a larger amount of fluid. (6) Evidence of extravasation† rather than of peritonitis.

It must be remembered that the following may mislead: There may be very little pain complained of; no sickness; a normal temperature; the patient may be able to walk; upwards of half a pint of urine may be drawn off night and morning, and yet the peritoneal sac may contain much fluid. Peritonitis may be absent post-mortem, though tympanites be present during life, and though fluid be found in the peritoneal sac. The patient may live as long as five days, apparently improving, and then die suddenly.

The following may be useful in doubtful cases:

Mr. Walsham, in his second case (*Trans. Med. Chir. Soc.*, vol. lxxviii. p. 278), to make certain of the existence of a rupture, made use of the injection of air, the injection of fluid not being conclusive. "For this purpose the india-rubber apparatus belonging to an ether-freezing microtome was utilised, the tube of which was attached to the free end of the catheter. The liver dulness having been carefully percussed out, a few cubic inches of air were forced through the catheter by two or three contractions of the rubber ball. The effect was instantaneous. The abdominal cavity became distended, the liver dulness immediately effaced, and the whole abdomen tympanitic to percussion. The patient fell into a condition closely resembling collapse; he complained of great pain, his respiration was laboured, and the action of the heart turbulent."

This method was recommended by two American surgeons, Dr. Morton and Professor Keen, independently, in 1890. Mr. Walsham was the first to employ it.

Operation.—The patient being under an anæsthetic, the abdominal wall cleansed and shaved, and the parts relaxed,‡ a free incision, 5 or 6 inches long in the adult, is made in the middle line. The linea alba having been divided, the recti retracted and partly detached if needful, all bleeding points secured, the lower angle of the wound and the parts behind the pubes are carefully examined for ecchymosis, extravasation, &c. If neither of these nor any collection of fluid is found outside the peritonæum, this is opened, when a large gush of fluid may be decisive. The surgeon now introduces one finger to feel for the rent, and the detection of this may be facilitated by passing a short-beaked sound. The rent will

* If the flow through the catheter is markedly increased by inspiration and diminished by expiration, the rent is probably a large one.

† Thus, if the rent is in front, the urine may be localized there with circumscribed dulness; or widely diffused, mounting up towards the umbilicus, between the abdominal muscles and the peritonæum; or passing into the iliac fossæ, or, by the canals, into the scrotum and thighs.

‡ In Mr. Willett's case (*St. Barthol. Hosp. Reports*, vol. xii. p. 209) much difficulty was met with from the rigidity of the abdominal walls, and the great distension of the intestines, which kept crowding out of the wound, and were most difficult to replace. Peritonitis had set in here, twenty-four hours having elapsed since the injury.

vary in site and length,* and also as to regularity, thickening, &c. If it be a long one, and reach downwards towards the recto-vesical cul-de-sac, the introduction of a rectal bag (Fig. 273, p. 994), may be of assistance. Sir W. MacCormac also found that the bladder came up more readily after the parietal peritonæum had been transversely divided on each side. An assistant with carefully cleansed hands may render service at this time by hooking up the bladder with two fingers, while the intestines are kept back with sponges. The rent, being now in view, is cleansed, and sutures of fine carbolized silk inserted. The shortest possible needle should be employed here, owing to the depth of the wound and the limited space there is to work in. Mr. Walsham in his second case found that a T. Smith's rectangular palate-needle answered admirably in inserting the deepest sutures. All of these should be put in before any are tied, and if the first are gently drawn upon it will facilitate the insertion of the others.† Sir W. MacCormac used sixteen sutures in one case and twelve in another, and his success is largely due to the great care with which they were inserted. Thus, they were put in $\frac{1}{4}$ inch apart, after Lembert's method (Fig. 183, p. 827), including the serous and muscular coats only, beginning at the lower part, the first and last sutures being inserted well beyond the limits of the injury so as to prevent leakage from the extremities. The following precautions are taken in passing them: Fine curved needles are used in holders; the serous surfaces are carefully inverted. The insertion of a finger into the rent will facilitate the passage of the deepest sutures. The sutures are passed through the serous and muscular coats only. This avoids the risk of traversing the mucous membrane, which in animals has nearly always proved fatal, because—(1) on tightening the sutures, the mucous membrane falls between the edges of the wound and hinders union; (2) the urine may find a channel through the points of passage of a suture, and so into the cavity of the peritonæum; (3) the loop of suture within the bladder is a foreign body, and salts may be deposited on it.

Wherever a gap appears, another suture should be inserted. If there is time, a few of chromic gut may be inserted through the serous coat only,‡ but Sir W. MacCormac regards the double row as unnecessary; 8 or 10 oz. of boracic acid are then injected into the bladder, to see if it is water-tight; or a coloured fluid, such as Condyl's lotion, may be used. A few more sutures may be required till this fact is absolutely certain. The peritonæal cavity is now most carefully wiped out with sponges on ovariectomy clamp-forceps, pushed well down into the pelvis and the flanks till they come out clean and dry on squeezing.

Where the surgeon is doubtful about the state of the peritonæal sac, or where irrigation has been used, a glass tube should be left in the pelvic pouch and sucked out. A catheter should be passed at regular intervals.

Cases occasionally occur where the neck and not the body of the bladder is lacerated, a fracture of the pelvis perhaps co-existing. Where there is inability to pass water and where it is uncertain whether a catheter enters the bladder, it will be best to explore the front and neck of the bladder by a supra-pubic incision not opening the peritonæum. If blood-stained fluid well up, and if the catheter be detached lying outside the bladder, the bladder should be opened and a curved staff passed through the urethra and cut down upon in the perinæum. A drainage-tube should then be passed according to the directions given at p. 1022.

* In Sir W. MacCormac's cases the rents were 4 and 2 inches long.

† In this case the rent was in the posterior wall extending from the summit along the middle line to the base of the trigone.

‡ Sutures through the serous coat only invariably give way.

This will drain the bladder effectually, and prevent any further escape of urine. The space outside the bladder, around its neck, must be cleaned thoroughly by the supra-pubic incision, tamponnaded with iodoform gauze, and, if needful, drained from the perinæum.

PUNCTURE OF THE BLADDER.

The following methods will be considered here :

- i. **The Aspirator.**
- ii. **Supra-pubic Puncture.**
- iii. **Puncture per Rectum.**
- iv. **Puncture through the Prostate.**

i. **The Aspirator.**—This may be used in cases of great urgency, when the surgeon is compelled to relieve retention without regard to the cause ; when he is without the means of carrying out other and perhaps better methods ; it is especially suited to those cases in which there is reason to believe that urine will again, in a few hours, be passed by the urethra. Thus, in gonorrhœal retention where a catheter cannot be passed, having perhaps been clumsily used, and where relief is urgently required ; where retention has supervened on a stricture of only two or three years' standing, this means may be used successfully, giving time for warm baths and opium to act. In an old stricture, in one of traumatic origin, or in a case of enlarged prostate, it can only be a temporary measure, and should only be used when other instruments are not available.

The question arises, *How far will aspiration bear repetition ?* This is quite uncertain. On the one hand, in a case of prostatic retention not admitting a catheter, the patient being, throughout, in a most grave condition, Dr. Brown (*Brit. Med. Journ.*, May 23, 1874) used the aspirator fifteen times between January 2nd and 12th, "with immediate relief on every occasion, and without the smallest inconvenience or injury from the punctures." Mr. Hague (*Lancet*, 1885, vol. ii. p. 385), in a patient, aged ninety, with prostatic retention of forty-eight hours' duration, aspirated, and continued to do so daily for nearly five weeks, as no catheter could be passed. Such numerous aspirations caused no ill effects.

On the other hand, in a case of mine of prostatic retention in which the aspirator had been used only three times, on the death of the patient from bronchitis on the fourth day, the third and last puncture was found to be leaking. Dr. Campbell (*Brit. Med. Journ.*, February 21, 1886) records a case in which the bladder had been aspirated twice, and internal urethrotomy then performed : "progress was good for a day or two, when some inflammation appeared at one of the punctures, an abscess formed, peritonitis came on, and the man died." Where aspiration is to be used, the condition of the bladder walls and of the urine must be taken into account.*

* Mr. Bennett read a case before the Medico-Chirurgical Society (*Lancet*, 1888, vol. 1. p. 418) of extra-peritonæal rupture of the bladder after aspiration in a patient long the subject of stricture. The opinion of most surgeons present seemed to be that aspiration was dangerously liable to leakage, especially in unhealthy bladders.

If aspiration be made use of, a fine needle should be employed, and introduced just above the pubes while an assistant steadies the bladder by pressure on either side. The bladder must not be allowed to become much distended before the puncture is repeated, otherwise urine may be forced out.

ii. **Supra-pubic Puncture.**—This operation has the *advantages* of being easily performed, of giving permanent relief if desired, and of being safe.

The two *objections* brought against it are, that (1) it gives bad drainage, and (2) it is liable to extravasation.* Neither of these is borne out by facts. While the patient is in bed, good drainage can be provided by turning him on one side and attaching tubing to the cannula; when the patient is up (and a cannula so placed is no drawback to this), the power of micturition will probably have returned. In a few cases of enlarged prostate the patient will be compelled to pass his urine this way for the rest of his life, but as soon as the parts are consolidated around the cannula, or the catheter which has replaced the cannula, micturition, though tedious, will be effected satisfactorily.

I may allude to three cases out of many in which I have used this method—two of retention with stricture, one of prostatic retention. I consider it the best all-round method, and the one of widest application that we have. Its relief is immediate, safe, and simple withal. The two cases of stricture were men under forty, admitted with a history of catheterism, bleeding urethræ, and recent false passages. On the fifth and second day, I was able to pass a No. 7 silver, and, in the third case, a coudée catheter. For some cases of older strictures, especially if with fistulæ and a damaged perinæum, a longer rest is required, and Mr. Cock's or Mr. Wheelhouse's operation is indicated.

Operation.—This is most simple. A median puncture having been made through the skin just above the shaved pubes, I prefer a curved trocar and cannula, the latter carrying tape-holes, but a straight trocar and cannula may be used, through which an 8 or 9 gum-elastic catheter, or, better, a Jacques' catheter, is inserted; in four hours the cannula can be removed, and a large catheter, a 10 or 12, introduced.† To keep the cannula firm at first, I insert a silver suture in the puncture, cover this with iodoform and collodion, and pack some strips of dry gauze around. I generally give a little anæsthetic, but this is not needed. The skin puncture is alone painful.

* Mr. T. Smith (*St. Barthol. Hosp. Reports*, vol. xvii. p. 291) writes: "I have seen no such tendency to extravasation; occasionally there is some inconvenience from leakage: this may be met by leaving out the cannula for a few hours, which allows recontraction to take place."

† If an aspirator has been used, and it is desired to replace it with a catheter, a catgut bougie should be passed through the cannula, and, this being withdrawn, a small gum-elastic catheter, with an eye in its point, is passed over the bougie. Larger ones can soon be got in, passing them with terminal eyes over the smaller ones, or by means of a stylet (T. Smith).

iii. **Puncture per Rectum.**—This has the advantage of draining a bladder well, but there are such serious disadvantages connected with it that the supra-pubic operation is always to be preferred to it.

Thus, (1) it is difficult and most unpleasant to the patient to retain the cannula during defecation and passage of flatus—the retention of a cannula is liable to cause troublesome tenesmus and diarrhoea; (2) when the cannula slips out it is difficult to replace it;* (3) the patient is kept in bed; (4) this method is not applicable to cases of enlarged prostate. I am aware that Mr. Bryant (*Surgery*, vol. ii. p. 153) states that “an enlarged prostate is no real obstacle to its performance, for this, if necessary, may be perforated with impunity.” I cannot at all agree with the above, in spite of Mr. Bryant’s authority. Being one of those who look upon an enlarged prostate, especially when congested with retention and surrounded by an enlarged venous plexus, as a structure to be treated with great respect, I think that there is an undoubted risk that perforating it may lead to septic phlebitis and abscess, and to suppuration in already impaired kidneys.

Mr. Bryant (*loc. supra cit.*) speaks very highly of puncture per rectum, and says that the objections raised against it are theoretical only—viz., abscess between the bladder and rectum, persistent fistulous opening, injury to the vesiculæ seminales or the peritonæum. I do not deny that these injuries are rare, but, as compared with supra-pubic puncture, the drawbacks which I have given above are practical and undoubted.

Operation.—If this method is employed, Mr. Cock’s instruments should be made use of—viz., a very sharp and a blunt pilot-trocar, and a cannula with inner tubes to keep the cannula in position and to admit of its being closed. The patient being in lithotomy position and the rectum emptied, the surgeon feels for the distended bladder, behind the prostate, with his left index finger. This being kept *in situ*, he introduces the cannula and blunt pilot along the finger up to the point he intends to puncture. The pilot being withdrawn, the sharp trocar is introduced, and, when it is nearly up to the hilt in the cannula, it is depressed and then driven on in a direction upwards and forwards, as if aiming for the umbilicus. The trocar is then withdrawn, the inner tubes inserted, and the whole secured with tapes. The urine is best conveyed away by tubing.

iv. **Puncture through the Prostate.**—Mr. R. Harrison † has advocated this method, and published a most successful case in a patient, aged eighty-four, with prostatic retention. A special straight trocar was introduced in the middle line $\frac{3}{4}$ inch in front of the anus, and pushed steadily through the prostate into the bladder, the left index being retained in the rectum. The cannula was removed in nearly three months, natural micturition gradually returning. Atrophy of the enlarged prostate appeared to follow, and the symptoms were much relieved.

I cannot but think that this method runs the risk of septic phlebitis (*vide supra*). Another objection is that the patient is kept in bed. Micturition becomes natural much more quickly after supra-pubic puncture.

* Thus, there are two specimens in Guy’s Hospital Museum proving, by the double puncture present, that this is the case.

† *Intern. Encycl. of Surg.*, vol. vi. p. 414.

CHAPTER XII.

OPERATIONS ON THE URETHRA AND PENIS.

RUPTURED URETHRA.—EXTERNAL URETHROTOMY.—
INTERNAL URETHROTOMY.—CHOICE OF OPERA-
TION FOR RELIEF OF RETENTION. — CIRCUM-
CISION.—AMPUTATION OF PENIS.—EPISPADIAS.
—HYPOSPADIAS.

RUPTURED URETHRA.

IN a few cases the surgeon may succeed in passing a catheter into the bladder. If he do so in a case where there has been much bruising* of the perinæum and extravasation of blood, a median incision should still be made to allow of relief to tension and escape of breaking down clots, and so give good drainage. If this is not done, the probability is great that a little later, owing to damage of soft parts, tension of blood clot, and a little escape of urine by the side of the catheter, this step will be required, at a time when, from the presence of traumatic fever, and the condition of the extravasated blood, the occasion is less favourable. Again, though a catheter can be passed at the time, it by no means follows that when, owing to its being plugged, or from some other reason, it requires removal in a few days that a fresh one can be inserted. An incision will then have to be made, and, as already stated, under conditions less favourable.

When, as is usually the case, a catheter cannot be passed into the bladder, the patient is placed in lithotomy position, and the parts having been shaved and cleansed, a grooved staff of as full size as the parts will admit is passed as far as it will go—*i.e.* to the site of the rupture, it is then made to project in the perinæum, and the surgeon entering a straight sharp-pointed bistoury in the middle line at a point 1 inch to $1\frac{1}{2}$ inch above the anus, pushes it on till it strikes the groove, and then cuts along this, both upwards and downwards, so as to expose freely the spot at which

* Complete rupture of the urethra may co-exist with a mere contusion of the perinæum, especially if much tenderness is present.

the urethra is ruptured. As the knife is brought out, the skin wound is enlarged till this is about $1\frac{1}{2}$ inch long, the lower end being $\frac{1}{2}$ inch above the anus.

With the finger clots are now turned out, and retractors being inserted deeply, the wound is sponged out thoroughly. A good deal of bleeding may now take place from some wounded vessel, hitherto closed by extravasated blood, or from the crus penis, detached on one side by the violence which ruptured the urethra, especially if there be a fractured pelvis. This hæmorrhage will yield to firm pressure or to forcipressure. The anterior end of the urethra is next readily found by the end of the staff, which projects through it, the finding of the deeper or vesical end, often difficult, will be facilitated by careful sponging, a mirror and reflected light, pressure above the pubes, and the use of fine probes or straight gum-elastic catheters. This end often projects as a small clot or bleeding-point; at other times it resembles a partly twisted artery.*

If it be found, a catheter of as large size as possible should always be introduced, if practicable, from the meatus, and then through the vesical end of the urethra into the bladder, guided by a finger in the wound, a Brodie's probe, or a Teale's gorget (Fig. 282). If this be found impracticable, a catheter should be passed into the bladder from the wound. One of these methods should always be made use of, if possible, as it enables the patient to be kept dry by tubing attached to the catheter.

But if no catheter can be got into the bladder, either along the penis or from the wound, the surgeon need not worry himself as long as a free exit has been given for the urine and extravasated blood. In these cases it is not unusual for the bladder to become somewhat distended during the first two or three days, owing to the urine not escaping with sufficient freedom, or to the closure of the vesical end of the urethra from swelling after the injury and the manipulations to find it, or from the patient, if a child, shrinking from passing his water. This difficulty will usually be met by hot flannels frequently applied to the abdomen, and a few doses of laudanum, but if it be evident that the urine does not escape with sufficient freedom, the surgeon must again examine the wound with the aid of an anæsthetic, clean out any fresh clots, and again try to find the vesical end of the urethra, aided now, perhaps, by a better light.

If this fail, supra-pubic tapping or aspiration, or if the patient's condition be good, making a small supra-pubic opening into the bladder and thence passing a short curved staff into the perinæum and so finding the vesical end of the urethra (p. 1022), must be resorted to.

Urethritis and cystitis are not uncommon in children. They

* The farther back the tear, the greater, of course, the difficulty in finding the urethra.

are best met by, as soon as possible, leaving out the catheter for a while.

With regard to the advisability of trying to use sutures, it is always advisable, if possible, to draw the ends of the urethra together on the catheter, with a fine curved needle on a holder, and chromic gut or carbolized silk. But this will often be found a matter of great difficulty, and even impossible. When effected, it does not diminish the need of subsequent regular use of catheters.

EXTERNAL URETHROTOMY (Figs. 280 to 284).

This operation includes the different forms of perinaal section with or without a guide—viz., Syme's, Wheelhouse's, and Cock's operation.

By some, **external urethrotomy** is reserved for those cases such as Syme's, in which a staff can be passed through the stricture, and "**perinaal section**" for those in which no such help is available—*e.g.*, Mr. Cock's operation. As, however, these terms are readily confused by students, and as in Wheelhouse's operation a staff is used, though it cannot be passed through the stricture, I think it preferable to employ the term external urethrotomy, specifying which operation is meant by using the author's name—viz., Syme's external urethrotomy, &c.

Syme's External Urethrotomy.—Here the stricture is divided on a fine staff (*vide infra*) passed through it.

Indications.—This excellent operation is strongly indicated in (1) cases of stricture which do "not yield to dilatation, or, rather, continue to present symptoms after being dilated"—in other words, to contractile, irritable, and resilient strictures, in which dilatation is accompanied with much pain, or in which it is found that a No. 7 can perhaps be passed one day and only a No. 3 a day or two after; (2) cases in which rigors and constitutional disturbance follow any attempt at dilatation.

Operation.—The patient, having been prepared by mild aperients and bland liquid diet for the operation, is brought under an anæsthetic, and while his legs hang over the end of the table, the surgeon introduces a Syme's staff. This has a narrow terminal portion, which passes through the stricture, a shoulder which rests upon the face of the stricture, and a wider, stouter part above the shoulder to make the instrument easier to find in the perinaum. The patient being placed, in a good light, in lithotomy position, and the parts cleansed and shaved, the surgeon makes an incision exactly in the median line down upon the staff, exposing the wider portion above the shoulder. When the surgeon is certain that this is laid bare, he runs the knife forwards along the groove, so as to divide the stricture completely. The staff is now withdrawn, and the rest of the treatment must vary somewhat. If the condition of the patient admits of it, a full-sized gum-elastic catheter should be passed from the meatus into the bladder, guided by a finger in the wound or in the rectum, or by a grooved director passed from the perinaum. If the irritability of the parts does not admit of this, a gum-elastic catheter must be inserted from the perinaum, cut short, and kept *in situ* with tapes, the urine running off, by tubing attached, into a basin containing carbolic acid; or Prof. Syme's curved perinaal catheter may be employed.

As soon as a catheter can be passed from the meatus, it should be kept in for two or three days, and changed, if needful, with an anæsthetic at first. As soon as possible, it should be passed twice a day, and the patient should be clearly told of the absolute necessity which exists of keeping up the good effects of the operation by the passage of an instrument at regular intervals, and of occasionally reporting himself to his surgeon.

Wheelhouse's External Urethrotomy.—Here the stricture is first found by a staff passed down to it, and then divided on a fine probe-pointed director passed through it.

Mr. Wheelhouse (*Brit. Med. Journ.*, June 24, 1876) recommends his method as having "the advantage of greatly increased precision; it renders an operation, confessedly hitherto one of the most difficult in surgery, a comparatively easy one, and one which, in my hands and in those of my colleagues, has given results infinitely more favourable, with an immediate and ultimate effect upon our cases, than we had ever seen before its introduction."

Operation.—"The patient is placed in lithotomy position, with the pelvis a little elevated, so as to permit the light to fall well upon it, and into the wound to be made. The staff* (Fig. 280) is to be introduced with the groove looking toward the surface and brought gently into contact with the stricture. It should not be pressed much against the stricture, for fear of tearing the tissues of the urethra and causing it to leave the canal, which would mar the whole after-proceedings, which depend upon the urethra being opened *a quarter of an inch in front of the stricture*. Whilst an assistant holds the staff in this position, an incision is made into the perinæum, extending from opposite the point of reflection of the superficial fascia to the outer edge of the sphincter ani. The tissues of the perinæum are to be steadily divided until the urethra is reached. This is now to be opened, *in the groove* of the staff, *not upon its point*, so as certainly to secure $\frac{1}{4}$ inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened, and the groove in the staff fully exposed, the edges of the healthy urethra are to be seized on each side with straight-bladed nibbed forceps and held apart. The staff is then to be gently withdrawn until the button-point appears in the wound. It is then to be turned round, so that the groove may look to the pubes and the button may be hooked on to the upper angle of the opened urethra, which is then held stretched open at three points thus (Fig. 281), and the operator looks into it immediately in front of the stricture. While thus held open, a probe-pointed director † is inserted into the urethra, and the operator, if he cannot see the opening of the stricture, which is often possible, generally succeeds in very quickly finding it, and passes the point onwards *through* the stricture towards the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths, in the midst of which the probe-point easily finds the true passage. The director having been passed into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downwards, the whole length of the stricture is carefully and deliberately divided on its under surface, and the passage is thus cleared. The

FIG. 280.



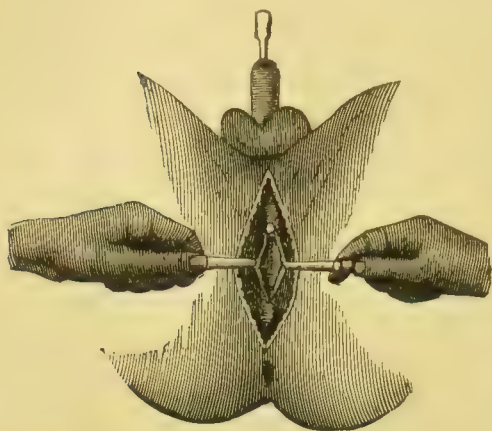
(Wheelhouse.)

* This is fully grooved through the greater part, but not through the whole of its extent, the last half inch of the groove being "stopped" and terminating in a round button-like end.

† Or a common blunt-pointed probe may be used. Occasionally a bougie (No. 2 or 3) is useful.

director is still held in the same position, and a straight probe-pointed bistoury is run along the groove to ensure complete division of all bands or other obstructions. These having been thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onwards into the bladder is to be overcome. To effect this, the point of a probe-gorget (Fig. 282) is introduced into

FIG. 281.



(Wheelhouse.)

the groove in the director, and, guided by it, is passed onwards into the bladder dilating the divided stricture, and forming a metallic floor, along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalized by an immediate gush of urine along it. A silver catheter (No. 10 or 11) is now passed from the meatus down into the wound, is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided, and is then, guided by the probe-gorget, passed easily and certainly along the posterior part of the urethra into the bladder (Fig. 283). The

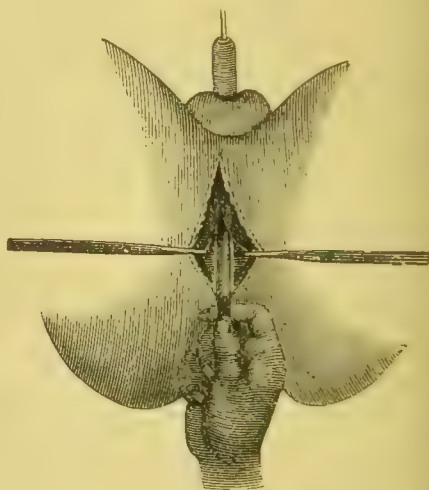
gorget is now withdrawn, the catheter fastened in the urethra and allowed to remain for three or four days, an elastic tube conveying the urine away. After three or four days the catheter is removed, and is then passed daily, or every second or third day, according to circumstances, until the wound in the perineum

FIG. 282.



Teale's probe-gorget.

FIG. 283.



(Wheelhouse.)

is healed ; and after the parts have become consolidated, it requires, of course, to be passed still, from time to time, to prevent recontraction." *

This will be found a most effectual operation, but in many cases the hitting off

* The wound should be syringed occasionally during the operation with a dilute solution of mercury perchloride, and a little iodoform dusted in at the close. If any bleeding is going on, the wound should be plugged around the catheter with strips of iodoform or sal-alembroth gauze, or Spencer Wells's forceps left *in situ*.

of the mouth of the stricture is a less simple matter than would be gathered from Mr. Wheelhouse's account. This is especially the case when the parts are engorged and softened, as the free oozing which is met with under these conditions may be most difficult to arrest even with firmly applied sponges on holders, the slightest trickling of blood being sufficient to obscure the orifice of the stricture. A false passage at the site of the stricture may complicate matters very much, and a stricture in the penile portion of the urethra may prevent the passage of the staff altogether. A good light, gentleness and patience are at all times requisite.

Cock's Operation.—An external urethrotomy, which opens the urethra behind the stricture, and without a guide (Fig. 284). The following, in the words of its deviser, are the *advantages* of this operation so well known to Guy's men (*Guy's Hosp. Reports*, 1866, vol. xii. p. 267): "The bladder is reached without any unnecessary mutilation of the perinæum. The communication is effected in nearly a straight line from the exterior to the cavity of the viscus, so that the cannula, which is inserted and retained, can be removed whenever necessary, and can be easily replaced. The functions of the entire urethra are suspended, and may be kept in abeyance for an unlimited period. The urine no longer finds its way abnormally through the stricture and sinuses of the perinæum. The tissues are no longer subjected to constant irritation from infiltration. The constitutional symptoms are relieved, and time and opportunity are given for the removal by absorption of those adventitious products which obstructed the urethra, indurated the perinæum, and rendered the introduction of an instrument impossible. The pressure on the kidneys is removed, and, if expedient, the bladder may be readily washed out, until its lining membrane assumes a healthy character. The strictured and damaged portion of the urethra being no longer subjected to the constant pressure of urine from behind, may probably so far recover itself as to allow of restoration by the ordinary means of dilatation; or, should the canal have become permanently obliterated, the patient still retains the means of emptying his bladder through the artificial opening without difficulty or distress, and at very moderate inconvenience to himself."

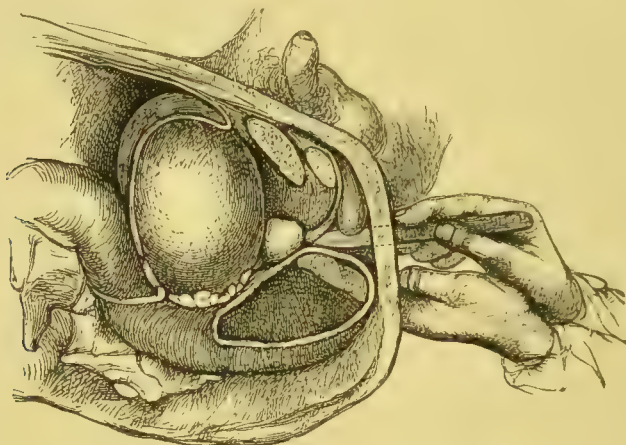
The following are *the cases to which the operation is well suited*: Where the stricture has existed for a number of years; where the urethra has become permanently obstructed or destroyed by the constant pressure of urine from behind, and by reiterated attempts, generally fruitless, to introduce an instrument; where extravasation into the perinæum has again and again taken place, causing repeated abscesses and their consequences, the formation of urinary sinuses and fistulæ, until the normal textures of the perinæum become obliterated, and are replaced by an indurated, gristly structure; where the bladder has become thickened and contracted by the constant action of its muscular coat until little or no cavity is left, and where the urine is constantly distilling by drops, either through the urethra or through one or several

fistulous openings, which dot the surface of the perinæum, penetrate through the indurated scrotum, and even find their way to the nates below, and the region of the pubes above. If unrelieved, these cases invariably terminate fatally.

The keystone of the whole proceeding is the fact that, "however complicated may be the derangement of the perinæum, and however extensive the obstruction of the urethra, one portion of the canal behind the stricture is always healthy, often dilated, and accessible to the knife of the surgeon. I mean that portion of the urethra which emerges from the apex of the prostate—a part which is never the subject of stricture, and whose exact anatomical position may be brought under the recognition of the finger of the operator."

Operation.—"The patient is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body

FIG. 284.



Mr. Cock's operation. (Bryant.)

and pelvis should be straight, so that the median line may be accurately preserved. The left forefinger of the operator is then introduced into the rectum, the bearings of the prostate are next examined and ascertained, and the tip of the finger is lodged at the apex of the gland. The knife is then plunged steadily, but boldly, into the median line of the perinæum, and carried on in a direction towards the tip of the left forefinger, which lies in the rectum. At the same time, by an upward and downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within $\frac{1}{2}$ inch of the anus.

"The knife should never be withdrawn in its progress towards the apex of the prostate, but its onward course must be steadily maintained, until its point can be felt in close proximity to the tip of the left forefinger. When the operator has fully assured himself as to the relative position of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced with a section somewhat obliquely, either to the right or the left, and

It can hardly fail to pierce the urethra. If, in this step of the operation, the anterior extremity of the prostate should be somewhat incised, it is a matter of no consequence.

"In this operation it is of the utmost importance that the knife be not removed from the wound, and that no deviation be made from its original direction until the object is accomplished. If the knife be prematurely removed, it will probably, when re-inserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when completed, represents a triangle; the base being the external vertical incision through the perinæum, while the apex, and constantly the point of the knife, impinges on the prostate. This shape of the wound facilitates the next step of the operation.

"The knife is now withdrawn, but the left forefinger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left forefinger, enters the urethra, and is passed into the bladder. A No. 12 gum-elastic catheter, straightened on its stylet, is slid along the director, the stylet then removed, the catheter cut short, and secured in position with tapes."

While most fully alive to the excellence of this operation, both as to speediness of relief and the perfect rest it gives to damaged parts, I should like to point out to those who are only likely to perform it occasionally, (*a*) that it is not such an easy operation as it appears; (*b*) that it is a severer operation than the size of the wound would suggest. Hæmorrhage is not very uncommon from the engorged condition of the parts, and a low form of septic phlebitis is not very infrequent after the operation. For these reasons I would restrict it to the cases mentioned at p. 1033.

Complications and Causes of Failure after External Urethrotomy.

1. Hæmorrhage (footnote, p. 1032). 2. Rigors. These should be met by warmth, leaving out the catheter or substituting a softer one; plenty of diluent drinks, washing out the bladder with diluted Thompson's fluid (p. 995), Dover's powders, or small injections of morphia, if the condition of the kidney admits of these. Five or ten grains of quinine may be given in milk every two or three hours, if it does not excite vomiting. 3. Septic troubles—*e.g.*, septic phlebitis. 4. Pelvic cellulitis. 5. Persistence of a fistulous opening in the perinæum. 6. Recurrence of the contraction.

CHOICE OF AN OPERATION FOR THE RELIEF OF STRICTURE-RETENTION.*

It will have been gathered from the remarks at p. 1025 that supra-pubic aspiration† may be used in very urgent cases, and

* Supra-pubic tapping has been already recommended for retention due to an enlarged prostate.

† In the absence of an aspirator, an ordinary hydrocele trocar may be safely used.

may be repeated safely once where this fails. In many cases where the patient is still comparatively young, where the stricture is not of long duration, where there are no urinary fistulæ or a damaged perinæum, the retention can be relieved and the cure of the stricture started by **forcible dilatation**. Ether or A. C. E. having been given, the surgeon takes a silver catheter with a short beak, No. 4, 5, or 6, and makes forcible steady pressure against the face of the stricture. The penis should be kept stretched by an assistant, so that the left fingers of the surgeon are free to keep note of the middle line. After a few minutes, perhaps aided by a smaller size of catheter, the point is felt to pass on, *in the middle line, without any jump, and without causing much bleeding*. The surgeon is thus sure that he has not made a false passage, and keeping touch of the passage of the catheter down the centre of the perinæum with his finger introduces this into the rectum. Here the pulp of the finger keeps the tip of the catheter a little up, and notices carefully whether the instrument is in the middle line and whether it is separated from the finger by a due thickness of tissues. If these points are secured and the point of the catheter moves freely, the surgeon may be assured that he has reached the bladder. I have used this method of careful forcible dilatation repeatedly, and think most highly of it.

Where this fails, for the large majority of cases of retention due to stricture, especially where the patient is under forty-five, and a few days' rest will ensure the passage of a catheter, I believe that **supra-pubic tapping of the bladder** will be the safest and simplest operation. This will be followed in four or five days by the passage of a catheter, aided by an anæsthetic, and guided by a little judicious force, combined with a knowledge of anatomy. **Wheel-house's operation** is very highly spoken of by the Leeds surgeons. A good light and especial instruments are essential. The cases to which **Mr. Cock's** excellent operation should be limited have been already pointed out (p. 1033).

INTERNAL URETHROTOMY.

Indications.—Before specifying these, I would say that, with regard to the question between external and internal urethrotomy, or the need of either, it is chiefly a matter of personal experience. In other words, surgeons who practise usually some such operation as that of Prof. Syme, and I confess I am of the number, when careful forcible dilatation aided by an anæsthetic fails, will probably have as good results as those who resort to internal urethrotomy. As it is a clean division of the entire stricture which is required, this can be effected most readily, and with less practice, and with simpler instruments, by external urethrotomy. But it must be remembered that, after all, it is not so much the division of the stricture, whether from without or within, which will be curative, as the amount of perseverance

which the patient shows afterwards. Again, at the commencement of internal urethrotomy, each stricture must be dilated sufficiently to admit, in the case of an instrument cutting from without inwards, a split sound equivalent to No. 2 English, while in instruments cutting in the opposite direction, the bulb is as large as No. 4 or 5. This being so, the cases must be very few in which the surgeon does not find it possible, and in which the patient does not prefer, to complete the case by dilatation.

Amongst these few cases are—1. Strictures localised and of the nature of annular, which (α) contract rapidly after dilatation, or (β) in which rigors persistently follow attempts at dilatation. 2. Non-dilatable strictures—*e.g.*, some traumatic ones. 3. Penile strictures. These are very elastic and shrink quickly after dilatation, and incision of these strictures seldom causes serious constitutional disturbance. 4. In some cases where time is an object. Thus, in young subjects whose disease has not existed long enough to alter the condition of the kidneys, cutting may be admissible for a stricture that should be simply dilated in an older patient whose kidneys have undergone degeneration (Berkeley Hill, *Dict. of Surg.*, vol. ii. p. 727). 5. According to some (Berkeley Hill, *loc. supra cit.*), urethrotomy affords a longer interval of freedom from contraction than does any other plan of widening a stricture.

Contra-indications.

1. Strictures not localised and ring-like, but extending over a considerable surface. 2. A "stricture" in which the difficulty is mainly due to congestion,* though this is scarcely a stricture at all. 3. A stricture accompanied by urethritis.

I have endeavoured to point out fairly the indications for internal urethrotomy. I suspect that this is one of those operations of which an increasingly frequent use is liable to lead to something very like abuse. But, however this may be, I should like to point out first a fallacy as it seems to me. Thus, Sir H. Thompson (*Dis. of Urin. Organs*, p. 40) speaks of a urethrotome as "nothing more than a little knife with a long blade . . . used precisely as we use a scalpel anywhere else. Just as we should use a small knife in tenotomy, without the sense of vision, where it is not necessary, but guided by the sense of touch, so do I advise you to act in urethrotomy." No doubt this comparison is correct as far as it goes, but its very simplicity is misleading. There can be no real comparison, I maintain, between division of a tendon, which can always be practically made subcutaneous, and that of a stricture, perhaps 4 inches from the surface, surrounded by vascular tissue, incision of which may easily lead to hæmorrhage or septic trouble, an incision which cannot from the subsequent flow of urine be completed aseptically, and which implicates other parts in such intimate sympathy with that operated on—*e.g.*, the kidneys.

Again, I would point out that internal urethrotomy is not the simple affair that it is sometimes represented to be. I would refer my readers to the experience of one whose name is associated with this operation. Mr. Berkeley Hill (*Lancet*, April 8, 1876, p. 524) speaks thus of a trial which he gave to the method of treating early stricture by Otis's operation of internal urethrotomy :

"All the cases operated on were those of long-standing gleet, with contraction in one or more parts of the spongy urethra, and had undergone multifarious

* As bearing upon the allied condition of "spasm," Mr. B. Hill (*Brit. Med. Journ.*, 1879, vol. ii. p. 856) stated that if an apparently narrow bulbo-membranous and a penile stricture co-exist, on the latter being properly divided, the former will disappear, having been due to reflex muscular contraction.

treatment. The number of patients is sixteen—fifteen of my own, and one of Dr. Otis's. In five cases the gleet stopped after the operation, and the patient was at the last report—taken in none less than three weeks, in most some months, after the operation—able to pass a bougie of the estimated size of the urethra. In short, they may be claimed as cures. But of these five the operation was serious to two; one had free bleeding for three days, the other three attacks of rigors. Of the remaining eleven, among whom Dr. Otis's own operation must be included, the gleet persisted in all; in several the urethra shrank again to its size before the operation, and in some very serious complications ensued. In four bleeding lasted several days and in one was alarming. Three patients had rigors; in two the shivering was unimportant, being that which follows the first transit of urine along the incised urethra in certain individuals, but is not repeated or attended by further consequences. In the third patient the rigors preceded abscess in the buttock. One patient had orchitis. Thus, in seven the operation might fairly be termed a trifle, causing no pain nor any after-fever, but in five only was the operation successful."

Complications.—(1) Hæmorrhage. If severe this may be met by pressure on the perinæum, with a pad or a stick in the bed so that the patient may keep up the compression himself. (2) Perinæal abscess. (3) Sloughing and perinæal fistula. These are very rare. (4) Extravasation. (5) Septicæmia. (6) Epididymitis. The first five of these are usually due to cutting too deeply, or to the patient not being sufficiently prepared or unfit for the operation. The last is usually brought about by injudicious haste in the use of bougies.

The essentials of a good urethrotome are: (1) a guide through the stricture into the bladder, usually in the form of a filiform guide-bougie, or of a curved terminal portion of the urethrotome, sufficiently fine to pass through the narrowest stricture; (2) a cutting edge which, at first shielded, can be protruded by the surgeon as exactly as he desires; (3) some means of steadying the mobile stricture fibres as they are divided.

Two Chief Modes of Internal Urethrotomy.—The stricture may be divided—(a) **From without inwards**—*i.e.*, towards the bladder. (b) **From within outwards**, away from the bladder. A short account of the chief instruments will be given, and the two methods briefly contrasted.

a. Those Cutting from Without Inwards.—By this means narrower strictures can be divided than in the other method, in which the instruments used are usually based on Civiale's pattern, in which the bulbous end carries the knife (p. 1037).

Most of the urethrotomes which cut from without inwards are modifications of Maisonneuve's pattern. A fine hollow staff being guided through the stricture by a filiform bougie, along the hollow staff a stylet carrying a triangular shield or wedge is run; this pushed against the stricture serves to steady it, while it is divided by a knife concealed in the wedge or shield.

One of the best known of the recent instruments on this pattern is Mr. B. Hill's. It consists of a narrow split sound, No. 2 English, which can be guided through narrow tortuous strictures by being attached to a filiform bougie, previously passed into the bladder.* Secondly, a wedge runs along dovetail grooves between the halves of the split sound. In this wedge is concealed a knife that can be protruded between the halves of the split sound, when the stricture-

* If it is doubtful whether the guide has reached the bladder, Mr. Hill advises to screw on a No. $\frac{1}{2}$ flexible catheter to the guide, and to push the whole onwards till the catheter has passed 8 inches inwards. A small exhausting syringe is then applied to the catheter, and a few drops of urine drawn through it.

issue prevents their separation sufficiently to allow the wedge to pass on. The edge,* pushed up to the situation of the stricture, in separating the split sound tightens and steadies the stricture (thoroughly, while the knife divides it to the width required by the wedge to pass along.† If a wedge be chosen to expand the urethra to its full natural capacity, the cut will not pass beyond the stricture to the vascular erectile tissue external to it. The knife can be applied to the upper or under surface of the stricture as preferred.

B. Those Cutting from Within Outwards.—A good representative of these instruments is Sir H. Thompson's modification of Civiale's urethrotome. This has a bulbous extremity, from which the blade is protruded. The stricture being sufficiently dilated to admit a No. 4 or 5 bougie, the bulb (which forms a useful sound) is carried about $\frac{1}{2}$ inch beyond the stricture, the knife projected, and the incision made by drawing it slowly and firmly outwards—to the distance of $\frac{1}{2}$ to 2 inches—generally along the floor of the urethra, so as to incise the stricture freely. A metallic bougie is then passed, and if at any point it is held closely, there is still almost certainly some spot which needs touching with the blade.

After-treatment.—This varies very much. Some surgeons—*e.g.*, Sir H. Thompson and Mr. Harrison—pass at once and tie in a full-sized catheter for twenty-four or forty-eight hours, passing after this a full-sized instrument at intervals. Others—*e.g.*, Mr. B. Hill—draw off the urine with a full-sized catheter, after division of the stricture, but tie none in. The patient is ordered not to urinate for eight hours if possible. By this time the incision is protected by clot and plastic lymph, and when the bladder must be emptied, the patient passes water in a hot bath, pain, spasm, and risk of tearing open the wound being thus avoided. The patient is kept in bed for ten days, and about the eighth day a full-sized bougie is passed, this period of rest being insisted upon to avoid pain, bleeding, and suppuration.

Comparison of the two Methods of Internal Urethrotomy.—With the instruments which cut from without inwards, guided by a filiform bougie, narrower strictures can be attacked than by the bulbous-ended urethrotome, cutting in the reverse direction. These latter have been recommended as giving the advantage of steadying the fibres to be cut by their pulling forwards the parts which attach the urethra to the pelvis, as the bulbous end of the instrument is drawn out. The stricture is thus pulled on by the instrument until the divided stricture gives free passage to the bulbous shield and the knife protruded from it. Mr. B. Hill, however, considers that "reliance cannot be placed on the simple straining of these attachments ensuring perfect division of the stricture tissue. A Civiale's or any other urethrotome which cuts from within outwards is very apt to wriggle its way through a stricture, only scoring it, but not perfectly severing its fibres, and to meet this difficulty the knife is often carried more deeply than is necessary." Mr. Hill further believes that by cutting from without inwards there is less risk "of making an incision through a thin layer of fibrous tissue into erectile tissue, in the belief that a thick layer of fibrous tissue exists," and thus of causing free hæmorrhage.

While myself usually practising what, on the whole, I believe to be preferable, continuous dilatation aided, if need be, by external urethrotomy, such as Prof. Meek's operation, I have, I trust, here fairly dealt with internal urethrotomy. Before leaving this matter I should like to allude to the question of *time*. Internal urethrotomy no doubt saves time and trouble also, but it must not

* The meatus must be divided, if too small to admit the wedge.

† After the first cut, the knife is withdrawn within the wedge, and only protruded when a tight band opposes the free passage of the wedge.

be thought that the saving is a large one. Thus, with regard to time, Mr. B. Hill writes: * "It is indispensable that the patient lie in bed continuously for at least ten days, and keep his room for fourteen days." Subsequent regular passage of a bougie is as needful after internal urethrotomy as any other mode of treating stricture.

ECTOPIA VESICÆ AND EPISPADIAS.

Owing to the misery which this condition entails, the surgeon may always be ready to operate, in the hope, at least, of making the wearing of a urinal easy and efficient, if he cannot secure the formation of a sufficient cavity to retain fluid: at the same time, from the contraction resulting from his operation, a partial or complete cure of the herniæ, which not unfrequently accompany this malformation, may be secured.

Age.—The cure of the ectopia may be commenced after the child is four or five, and should be completed, if possible, by puberty. In this case the epispadias may be taken in hand and completed before adolescence, when the growth of hairs and sexual desires will interfere much with the union of the flaps.

Unfavourable Conditions.†

1. Large size of the ectopia, with much bleeding and some purulent discharge from the surface. 2. A sickly condition of the patient, pointing to poor powers of repair, and a waddling gait to wide separation of the pubes. 3. Tendency to cough. This increases the protrusion. 4. Presence of large herniæ. 5. Secondary dilatation of the ureters and pelves of the kidneys, with degeneration of viscera.‡ 6. Obstinate eczematous rawness. 7. Small size of the scrotum. This is rare.

Preparatory Treatment.—If the patient has passed puberty, and the hair is at all abundant, depilation should be practised, and nitric acid applied at intervals to the groups of hair-follicles.

It may be well also to try and diminish the size of the ectopia by the means adopted by Mr. Greig Smith, who, for some weeks previous to operation, kept the patient on his back, and the exposed mucous membrane shielded with green "protective" coated with dextrine, covering this over with boracic lint, and by this means, in one case, the mucous membrane not only became less angry, but its upper half, almost as low as the ureters, became covered with epidermis almost as white as the surrounding skin.§

Operation.—An anæsthetic having been given, a median flap || is raised from the

* *Dict. of Surg.*, vol. ii. p. 729. See also the Lectures, alike candid and helpful in detail, by the same surgeon (*Brit. Med. Journ.*, 1879, vol. ii. pp. 763, *et seq.*).

† For full information on all these matters Mr. J. Wood's articles (*Dict. of Surg.*, vol. i. p. 425, and *Med.-Chir. Trans.*, vol. iii. p. 85) should be consulted.

‡ Mr. Wood (*loc. supra cit.*) shows that sometimes the above complication may be recognised by the presence of more albuminuria than is accounted for by the amount of cystitis. In other cases no such signs are present. Out of forty cases, a fatal result, chiefly from this cause and undetected, followed in four.

§ In another case, also successfully operated on, no preliminary treatment was of any avail in diminishing the size of the ectopia.

|| The shape and arrangement of the flaps is excellently shown in pl. ii. figs. 1 and 2 accompanying Mr. Wood's paper (*Med.-Chir. Trans.*, vol. lii.). Some illustrations of other flaps in a paper by Mr. Mayo Robson (*Brit. Med. Journ.*, 1885, vol. i. p. 222) will also be found useful. And I would direct my reader's attention to a paper by Mr. W. Anderson (*Clin. Soc. Trans.*, vol. xxv. p. 78), which contains, as might be expected, some very helpful drawings.

abdominal wall above the exposed bladder. Its shape resembles that of the wooden portion of a fire-bellows, its length is rather greater than the distance between the root of the penis and the upper margin of the exposed bladder, while its root must be sufficiently broad to ensure a sufficient blood-supply. In raising it, care must be taken not to cut it too thin, and, at the same time, not to go too deeply with the point of the knife, as the tissues here are extremely thin, and the flat, tense, expanded linea alba beneath is often very thin, and thus the peritonæal sac may easily be opened.

The two groin flaps are next made, of rounded oval shape, with broad pedicles, the outer boundary of which is sufficiently carried out on to the thigh, and then on to the root of the scrotum, to ensure its containing the superficial epigastric and the external pudic arteries. The inner margins of these flaps join those for the central flap at about its centre, and are then continued down along the side of the urethral groove for about half its length.

While these flaps must be cut as thick as possible, care must be taken to avoid any subsequent hernia, and they must be sufficiently detached to meet for their whole length, without tension, in the middle line. In raising them they must be handled as carefully as possible, whether with fingers or with bluntly serrated forceps, so as in no way to impair their vitality. All bleeding having been stopped, the flaps washed with boracic-acid lotion, and their surfaces allowed to become glazed,* the umbilical flap is first taken and folded down, with its skin surface towards the bladder, evenly and without tension. It is then stitched to the cut edge at the root of the penis.

The groin flaps are then drawn inwards, placed with their raw surfaces upon the raw surface of the umbilical flap, and carefully stitched together. The sutures should be many and mixed, of wire, carbolised silk, fishing-gut, and horsehair. Wire has the advantage of being non-irritating and of keeping sweet in a wound which cannot be kept aseptic. The sutures should be left in for a fortnight, and, in the case of children, it may be well to give an anæsthetic to take them out.

The raw surface from which the central flap was taken is then closed, as far as possible, with long hare-lip pins and twisted sutures. The rest of this wound may be closed, now or later on, by Thiersch's method of skin-grafting (p. 560).

The parts are then painted with collodion and iodoform, and sal-alembroth ointment applied, and the buttocks and hips smeared with eucalyptus and vaseline. If any redness appear, wet boracic-acid lint dressings should be made use of.

Prof. Trendelenberg (*Centr. f. Chir.*, No. 49, Dec. 1885) published a case of retroversion of the bladder in which immediate union of the lateral margins was obtained by previous division of the sacro-iliac synchondroses. By entirely freeing the joints and breaking their sides free this surgeon has gained an approximation between the anterior superior spines of two inches in a child of two and a half. This approximation is of course only rendered possible by the fact that the symphysis pubis is deficient in these cases. When the bones are thus approximated the lateral margins of the defect are pared, and brought together with sutures. This, when successful, effects a great saving of time, and secures that the cavity of the bladder shall consist, save for a narrow line of scar in front, of vesical mucous membrane and not of scar-tissue. As a result the formation of phosphatic deposit is greatly diminished. A very interesting account of this operation has been given by Mr. Makins with a successful case (*Trans. Med. Chir. Soc.*, vol. lxxi. p. 191). To be successful the division of the synchondroses should be performed early, *e.g.*, before the child is five.

* Spencer Wells' forceps should be left for five or ten minutes on any bleeding points, and all ligatures, even of fine chromic gut, dispensed with, if possible. Boiling will yield to firm sponge-pressure.

After-treatment.—The patient must be kept partly sitting, the shoulders being well propped up and the knees flexed; a bandage passed from the knees around the shoulders will facilitate this. Any sudden straightening of himself by the patient is fatal to a good result. For the first few days small opiates or injections of morphia will be required.

HYPOSPADIAS.

I have only space to allude to some practical points which may be useful to a surgeon when consulted about the advisability of an operation.

Varieties.—These are three, viz.: 1. Glandular.—The opening is here merely further back than usual, the frænum is absent, the glans broad, flattened, somewhat recurved, and the prepuce, often hood-like, always in a condition of partial paraphimosis. 2. Penile.—Here the urethra is especially liable to open at one of the three following sites: (a) Just behind the glans; (b) at the middle of the penis; (c) at the junction of the penis and scrotum. 3. Scrotal.*—Here the cleft on which the urethra opens may be either at the junction of the penis and scrotum, or involve the scrotum and perinæum, the former being called peno-scrotal, and the latter perinæo-scrotal.

When an operation is under consideration, with a view of rendering micturition and coitus normal, the surgeon must take into due consideration—(a) the degree of the deformity; (β) whether the penis is fairly developed; (γ) whether it is much tied down; (δ) whether the testicles are present and descended; (ε) how far the patient's condition is made miserable by rawness and eczema due to impeded micturition, and by impeded coitus; and how far there are reasonable hopes of remedying these.

Operation.—I shall describe here that of M. Duplay, of the Lariboisière Hospital. He divides the restoration into the following three stages, which require, in order to be successful, much time and patience on the part of both surgeon and patient:

i. *Straightening the penis and formation of a meatus*; ii. *Formation of a canal from the meatus to the hypospadiac opening*; iii. *Junction of the old and new canal.*

i. *Straightening the Penis.*—In the penile, peno-, and perinæo-scrotal varieties, the penis, often short, is recurved,† especially during erection, by a band consisting partly of a muco-cutaneous ridge, corresponding to the absent urethra, and reaching from the hypospadiac orifice to the glans. M. Bouisson seems to have first pointed out the importance of dividing this, which he did subcutaneously (p. 1043). M. Duplay recommends division by an open wound, carrying the incision as deeply as needful, and states that the corpora cavernosa may be incised to a very considerable depth, if needful to secure this end. M. Duplay's incision leaves a lozenge-shaped wound, which he unites by sutures (Fig. 285 B and C).

At the same time the above-named surgeon forms a meatus. This is done by paring the two lips of the depression which represents the meatus, and uniting these over a bit of catheter. If the depression be very shallow, an incision upward into the glans-tissue, or two lateral ones, may be needed before it is possible to insert a catheter, and to apply sutures round it.

ii. *Formation of a New Urethra.*‡—The penis being held up, two incisions are

* The above is sometimes divided into two, scrotal and perinæo-scrotal.

† This recurving is also in part due to thickening and shortening of the capsule of the corpora cavernosa, and even of the septum.

‡ Several months, at least five or six, must elapse before the surgeon is certain that no recurving will occur. This disappears very gradually.

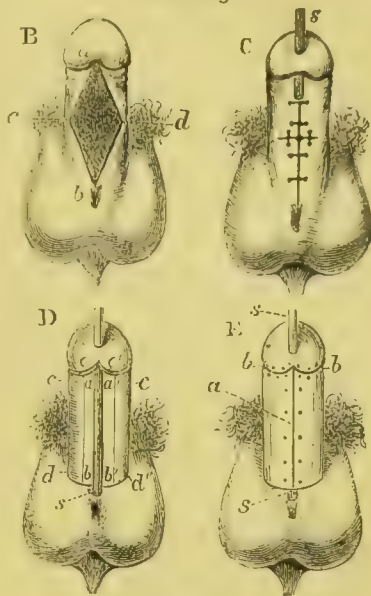
made a little outside the lateral margins of the mucous surface corresponding to the deficient urethra, and reaching from the glans to the hypospadiac orifice. By making two transverse incisions at either end, two narrow quadrilateral flaps, *a, b, a', b'* (Fig. 285) are dissected up towards the middle line until, with their mucous surfaces turned inwards and their raw surfaces outwards, they meet without tension over, and thus shut in a catheter passed from the previously restored meatus to the hypospadiac orifice. These flaps are now united with sutures, partly of fine chromic gut and partly of fine carbolised silk, cut quite short. From the sides of the penis two similar flaps, *c, d, c', d'* (Fig. 285) are dissected up from within outwards, till they can be sufficiently drawn inwards without tension to cover over the raw surfaces of the internal flaps. They are then carefully united in the middle line (Fig. 285). I much prefer horsehair and fishing-gut sutures here, well soaked previously in warm carbolic acid.

In operating upon boys and I consider nine to fifteen as the best age, I prefer, in penile hypospadias, to make the new glans and restore the floor of the urethra at one sitting. Any points where union fails can be closed later. The chief trouble is the retention of the catheter sufficiently long. I have usually found that after the third day the delicate mucous membrane of a child's bladder resents the catheter, —a very little mucus quickly plugs these small instruments—and a nurse must be instructed to pass a small india-rubber catheter every two or three hours. In the intervals a short bit of bougie is kept in the new urethra and glans to maintain the patency of the canal. Iodoform and collodion with a dry dressing of iodoform gauze are the best dressing.

Mr. Makins describes (*Lancet*, 1894, vol. ii. p. 1141) a method of restoring the urethra in hypospadias, in which Thiersch's operation is ingeniously modified. By the use of three tiers of suture not only is the new urethra built up firmly, but the prepuce is restored as well.

iii. *Joining the Old and New Urethra.*—As soon as the new urethra is thoroughly established, quite closed, and shows no sign of contraction, this last stage may be undertaken. The edges of the posterior end of the new urethra and those of the remaining orifice having been freely vivified, and a catheter passed from the meatus into the bladder, the opening is closed over it by sutures as in stage ii. A catheter—one of Jaques' pattern is least painful—should be kept in the bladder if possible, till all is water-tight.

FIG. 285.



(Bryant.)

EPISPADIAS.

I am unable to find space for any really full account of the different attempts to cure this rare condition. For some points of practical importance I would refer my readers to the remarks on hypospadias (p. 1042).

Any attempt at curing epispadias should be divided into three stages, thus :

i. *Straightening the Penis.*—While the penis is short, recurved, so as to lie in contact with the abdominal wall, it is no use trying to complete the defective urethra. Attempts should be made to straighten the penis by dividing it subcutaneously close to the pubes, each corpus cavernosum being cut separately. In

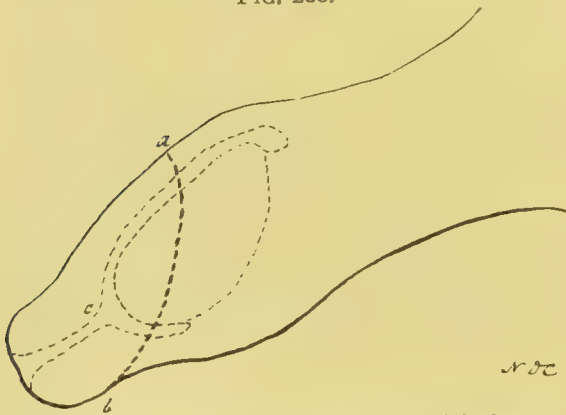
the only case in which I practised this, in a patient aged seventeen, the hæmorrhage was easily controlled by dry gauze and light pressure, but very sharp tenotomes must be employed, as the erectile tissue offers much less resistance than a tendon. Each corpus cavernosum should be divided completely, and as cleanly as possible. The penis must, for some time, be kept fastened down; improvement in its position takes place gradually, together with increase in its length, this being, eventually, more marked the earlier the operation is performed.

ii. *Completion of the Deficient Urethra from the Meatus to the Epispadiac Opening.*—The simplest way of effecting this is by the method of Thiersch and Duplay, much as in hypospadias, to the account of which I would refer my readers. Two narrow quadrilateral flaps extending from the meatus to the epispadiac orifice are marked out and dissected up from without inwards on either side of the open urethra, both being left attached in the middle line. These turned with their muco-cutaneous surface inwards, over a small Jaques' catheter, to form the new urethra, and their raw surfaces outwards, are united in the middle line with numerous points of sutures cut short and buried (p. 1043). Thin flaps dissected up from within outwards from off the dorsum and sides of the penis are then drawn inwards, raw surfaces being thus opposed to raw surfaces, and kept *in situ* by numerous points of sutures.

iii. *Junction of the Old and New Canal by Closure of the Epispadiac Opening.*—This is effected by freely refreshing the surrounding parts and suturing them carefully. Before the union is complete several operations may be required, both for this condition and hypospadias.

CIRCUMCISION (Figs. 286, 287, 288).

Trivial as this operation seems, it is so important, especially in adults, to secure speedy healing, that it will be briefly alluded to here.



a, b, Shows the line of incision by which the prepuce is removed. *c,* The point of constriction of the mucous membrane which causes the phimosis. The finer dotted line shows the mucous membrane lining the prepuce and covering the glans. (Davies-Colley.)

Indications.—This operation is still not practised often enough, especially amongst poorer patients, where many practitioners still treat phimosis as a matter of but little importance. Hospital surgeons have, only too often, opportunities of seeing the following results follow from the above course:—(a) Balanitis and adhesions. (b) Paraphimosis, from the forcible retraction of a

phimosed prepuce. (c) From the impediment to micturition, urethral, and vesical irritation, and even cystitis, may be set up, simulating the symptoms of stone. (d) Hernia and prolapsus recti. (e) The sexual feelings too early induced, and bad

habits.* (f) Impediments to intercourse. (g) Intensified gonorrhœa, chancres, &c. (h) Epithelioma.

Operation.—This may be performed in many different ways, but the following points must be remembered in every case: (1) To remove enough of the mucous layer of the prepuce. If this be not done, some tension on the glans remains, and this leads, especially in adults, to troublesome erections which interfere very much with the process of healing; later on, some degree of phimosis is certain to persist. (2) Not to leave too much tissue about the frænum.

Mr. Howse (*Guy's Hosp. Reports*, 1873, p. 239) has drawn attention to the fact that the cellular tissue at this spot is loose, and that the presence of the frænal artery makes probable the gathering of blood and inflammatory effusion at this spot. In children this is a matter of less importance, but in adults it may lead to the formation of a tediously persistent lump, interfering with the function of the organ.

(3) Not to remove too much of the prepuce. Thus, it is always well, in adults especially, to leave enough to cover easily the sensitive papillæ with which the corona abounds. Again, in the diminutive organ of infants, it is very easy to remove so much as to nearly flay the body of the organ.

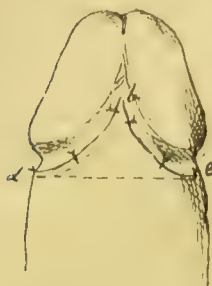
The following is a very simple mode of operating: The prepuce having been separated as much as possible from the glans with the finger and thumb, or a stout probe, a pair of dressing-forceps is lightly placed on the penis at a level with the corona; the glans being next allowed to slip back, the forceps are closed, and all the prepuce in front of the instrument is cut off with a sharp scalpel used with a rapid sawing movement. The following directions given by Mr. Davies-Colley (*Guy's Hosp. Rep.*, 1892, p. 164) are worth remembering at this early and most important stage of the operation. "The incision should begin upon the dorsum, at a point corresponding to that part of the glans which is halfway between the meatus and the corona. The incision should be made downwards and forwards, so as to leave a sharp point in the middle of the under surface (Figs. 286, 287). The object of this pointed projection is to fill up, subsequently the triangular interval, which is otherwise left when the portion of the mucous membrane of the prepuce, to which the frænum is attached, is removed. The blades being at once removed, the mucous membrane is then slit up with a director and scissors or a sharp-pointed bistoury,† this incision running up to, but not beyond, the corona. The mucous membrane, if still adherent, must be peeled in two flaps from off the glans, this

* Prof Sayre (*Orthopædic Surgery*, p. 14) describes cases in which paralysis of certain groups of muscles, leading to talipes and other deformities, followed on early sexual excitement, due to phimosis. See also the case recorded by Mr. Hilton (*Rest and Pain*, p. 276).

† It is well at this stage to make tension on the loose prepuce with two pairs of dissecting forceps, and thus secure a clean section.

detachment being effected by the finger and thumb, or by a stout probe swept round. The cut edges of the prepuce are then

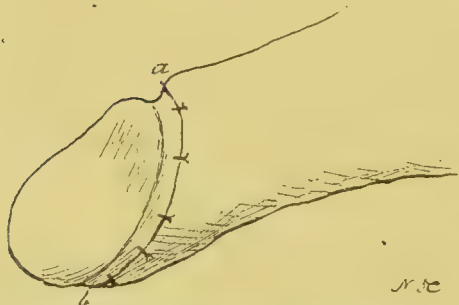
FIG. 287.



The pointed process of skin (*b*) is shown adjusted in the angle left by the remains of the frænum. The dotted line (*b*, *d*, *e*) shows the edge left on the skin and the triangular bare surface which has to heal by granulation unless precautions are taken to preserve the triangular flap of skin as directed above. (Davies-Colley.)

flaps to carry the sutures and no more. The frænal artery can usually be secured by transfixing it with one of the sutures; if

FIG. 288.



The penis after the edge of skin has been sutured to the frill of mucous membrane left along the corona. (Davies-Colley.)

Thomas's Hosp. Reports, vol. xvi. p. 198), kept in place by iodoform and collodion. When the parts are at all swollen, or where erections are likely to be troublesome, I prefer boracic-acid dressings, two layers of boracic-acid lint wrung out of an iced saturated solu-

rounded off with scissors, which follow the curve of the glans as far as the frænum. Just a frill of mucous membrane, and no more, should be left all the way round the corona (Fig. 288). Enough prepuce should be left to cover over the corona-papillæ, and to admit of easy stitching. Chromic gut and horse-hair make the best sutures. Very fine needles should be used, and the sutures passed quickly through skin and mucous membrane with a stabbing movement, and without bruising the edges with forceps. In passing the sutures any bleeding-points must be transfixed, and the abundant cellular tissue* kept in its place with the point of a probe. The frænum is now attended to, the prepuce which is still attached here being cut away carefully by V-shaped cuts, pointing forwards, and leaving just enough

flaps to carry the sutures and no more. The frænal artery can usually be secured by transfixing it with one of the sutures; if not, it is readily tied with a fine chromic-gut ligature.

I much prefer interrupted sutures of chromic gut for circumcision; a continuous suture often gives good results in healthy subjects, but the former has the great advantage that one or two can be removed, if needful, without interfering with the rest. The majority soften away.

One of the following dressings will be found the best. I like most of all the dry gauze dressing advised by Mr. Ballance (*St.*

* This must on no account be cut away, as in it run the vessels to the prepuce. All bleeding must be stopped, especially in adults, or extravasation of blood in the loose connective tissue leads to tension, cutting through of sutures, and sloughing.

tion of the lotion. The deeper layer has a hole cut to allow of micturition and is only removed by the surgeon, the outer one envelops the whole penis, and may be removed and re-wetted by the patient, though usually it is sufficient for him to keep it wet by dropping on a little lotion from time to time. For children and hospital practice I have come to the conclusion that on the whole nothing answers better than carbolic oil. The dressing is not disturbed for two or three days, and the mother has instructions to keep it moist by oil dropped on at intervals.

After circumcision the patient should rest as much as possible. Thus, an adult should stay in bed for forty-eight hours and keep on the sofa for a week, alternate stitches being removed at intervals. If he insist on getting about too early, he must run the risk of the parts remaining long œdematous and tender. And for this reason, with hospital patients, who have to come backwards and forwards, early and complete healing is not to be expected.

AMPUTATION OF THE PENIS (Figs. 289-292).

Indication.—Epithelioma of penis.—I would refer my readers to the remarks made at p. 360 on the pre-cancerous stage in epithelioma of the tongue. Though epithelioma of the penis is much less common, lives are, here also, too often lost by allowing the case to get beyond this stage. Any suspicious excoriation, ulceration, or wart should be early destroyed with the acid nitrate of mercury, or excised. Where, after this treatment, satisfactory healing does not take place, early and thorough removal of the part should be performed. There should be no dangerous waiting, because the surgeon is unable to satisfy himself whether the case is one of inflammatory induration or infiltration from new growth. In such cases, especially where there is a doubtful history of syphilis, much valuable time has been often lost with drugs, which, even if the lesion does date back to some long-past syphilis, are quite useless if epitheliomatous ulceration has set in. Furthermore, the longer ulceration continues, the more extensively will the inguinal glands be involved. In such cases, though the penis may be satisfactorily operated upon, disappointment will speedily follow, owing to the outbreak in the inguinal regions. Scarcely any surgical case presents a close more distressing, both to the patient and those around him, than one of breaking down of epitheliomatous glands, owing to the hideous ulceration, the noisome discharge, and the steady decay of bodily strength.

In a very few cases, when the disease commences around the meatus, it may still be possible to remove the affected part without interfering with the body of the penis. It seldom happens, however, that we see the case early enough for this, and it is usually necessary to remove the whole of the glans and more or less of the corpora cavernosa. Before doing this, the prepuce, unless it

admits of being retracted, should invariably be laid open, so as to expose the growth and make quite sure of its real nature.

Operations.

I. Galvanic Cautery.—I am as much against this method here as in the case of the tongue (p. 375). The dread of hæmorrhage still induces some to resort to it; it is not, however, a sure preventive. Sharp bleeding has followed a few hours after the operation, and also, later on, during the detachment of sloughs; furthermore, this operation leaves a much more troublesome and sloughy wound than the knife. This is not a matter of slight importance in these patients, in whom, usually advanced in years or prematurely aged, pulled down in health, and often depressed in mind, tedious healing of the wound (which it is difficult to keep sweet) involves a prolonged keeping the patient on his back, with the risks of broncho-pneumonia, erysipelas, &c. The need of a special,

FIG. 289.



Flap amputation of the penis. The appearance of the stump, with the urethra slit up and stitched *in situ*, is shown above. The flap has been raised too near the disease below.

expensive instrument, and the unpleasant factor of the operation, are also objections.

If the surgeon make use of it, a No. 4 or 6 catheter should first be passed; the loop of wire is then tightened around the penis, well behind the disease, and kept there by one or two pins. When the current is passed, care must be taken that by tightening the wire very slowly, and watching the amount of heat, the vascular structures are not severed too quickly; otherwise hæmorrhage, very difficult to arrest on a seared surface, is certain to follow. The catheter is cut through by the heated wire, and the urethra, thus maintained patent, is slit up and stitched as directed below.

II. Circular Amputation.—This gives good results, though not equal, in my opinion, to those which follow the flap method. The vessels being commanded, the skin is drawn a little forward to prevent any superabundance afterwards, and the amputation is effected by a single sweep of the knife. The vessels and the urethra are treated as directed below.

III. Flap Amputation (Figs. 289, 290).—This method has been followed by rapid healing, and has given an excellently covered stump in the eleven cases in which I have made use of it. Hæmorrhage having been provided against by one of the above-given means, the surgeon enters a narrow-bladed knife, at a point well behind the disease, between the corpus spongiosum and the corpora

cavernosa, and then cuts forward and downwards for about $\frac{3}{4}$ inch. From this small inferior flap the urethra is dissected out. A flap of skin is now cut from the dorsum and sides of the penis, resembling in miniature the upper skin-flap in amputation of the thigh. This flap being held back, the corpora cavernosa are divided vertically upwards on a level with the point of transfixion. Any vessels which can be seen are now tied with chromic gut or

FIG. 290.



A case of amputation of the penis by the flap method one year and a half after the operation. Scars of operations for the removal of glands (enlarged inguinal glands were removed at the time of the operation) are seen in either groin. The two dots mark the points where drainage tubes were brought out. The patient died two years after the amputation of gland disease. There never was any recurrence in the penis. (*Diseases of Male Organs of Generation.*)

carbolized silk. On removal of the drainage-tube, clamped with Spencer Wells' forceps, and securing any spirting vessels, free oozing often takes place, but ceases spontaneously. All hæmorrhage being arrested, the upper flap is punctured, and the urethra drawn through the face of the flap, slit up, and stitched *in situ*. The two flaps, upper and lower, are then united by a few points of carbolized silk and horsehair suture.

This method secures a natural skin-covering for the severed corpora cavernosa, and prevents the delay and irritation which healing by granulation entails. A similar operation was, long ago, suggested by Prof. Miller of Edinburgh, but this surgeon cut his flap from below. If, as I have recommended, the flap is taken from above, the skin will be found to fall into position more readily over the raw surfaces of the corpora cavernosa. After all these opera-

tions the patient should pass a short piece of bougie, at regular intervals.

Occasionally, **severer operations** are entirely justifiable.

Thus, where the penis is involved as far back as the scrotum, the entire penis should be extirpated, if the inguinal glands are not seriously involved, and if the powers of repair are satisfactory. The patient being in lithotomy position, the scrotum is to be split deeply along the whole length of the raphé, and the corpus spongiosum carefully dissected out. This step may be facilitated by passing a

FIG. 291.



Appearance of parts after amputation of two-thirds of the penis by splitting the scrotum. The patient refused castration. The urethra is at the lowest part of the scar. (*Diseases of Male Organs of Generation.*)

large sound. When the triangular ligament is exposed, the above instrument is removed, and the corpus spongiosum which has been dissected out is cut through, enough being left to bring out in the perinæum. By means of a blunt dissector, the crura are then detached on either side from the pubic arch, and the incision being prolonged around the penis above, the suspensory ligament is divided, and the dorsal arteries secured. The cut end of the corpus spongiosum is now slit up and stitched in the posterior part of the scrotal incision, and all the rest of the wound closed by sutures. Drainage must be provided by a small tube, or by horsehair drains. Similar operations to the above have been performed on several occasions, but the important modification of dissecting off the crura, and thus ensuring complete removal of the cancerous organ and its capsule, was brought before the notice of English surgeons by Mr. Gould (*Lancet*, 1882, May 20, p. 521).

In most cases of amputation of the penis the patients will be wise in consenting to castration—an operation which will add in

many cases largely to their comfort, and at a very slightly increased risk. (Wheelhouse, *Brit. Med. Journ.*, 1886, vol. i. p. 187.)

Question of Removing Enlarged Glands.—These should always be extirpated as soon as it is probable that the enlargement is not merely inflammatory. A week's watching, with rest, lead lotion, or the inunction of mercury oleate (10 per cent.), aided by pressure, will settle this point. As long as the glands are involved by growth only, hard and separate from each other, care-

FIG. 292.



The appearance of the parts a month after complete amputation of the penis, castration, and removal of enlarged glands. The opening of the urethra is not seen, being situated at the perinæo-scrotal junction. The dots mark the counter-punctures for drainage-tubes. (*Diseases of Male Organs of Generation.*)

ful dissection will often succeed in shelling them out, and thereby add materially to the prolongation of the patient's life. But where they contain not only secondary deposits, but also inflammatory matter, owing to ulceration having set in at the seat of the primary lesion, satisfactory removal of the glands is always a matter of great difficulty and often impossible, owing to their softness and tendency to break down, to their adhesions to their capsules, and the matting of these to the surrounding parts, the vascularity of which is increased, and tendency of the overlying skin to become adherent.

In all such operations the parts should be disturbed as little as possible, as erysipelas, sloughing, and superficial gangrene are very likely to follow these operations where planes of fascia are much interfered with, and where the blood-supply is but poor.

The wound should be irrigated from time to time during the operation with a solution of mercury perchloride, 1 in 4000.

Iodoform and sal-alembroth gauze dressings, or boracic-acid lotion, if erysipelas is feared, will be found the best.

For much fuller information on this and many other points I may refer my readers to my *Diseases of the Male Organs of Generation*, pp. 707-745.

CHAPTER XIII.

OPERATIONS ON THE SCROTUM AND TESTICLE.

RADICAL CURE OF HYDROCELE.*—VARICOCELE.— CASTRATION.

RADICAL CURE OF HYDROCELE.

IN a paper written nineteen years ago (*Lancet*, Sept. 1, 1877), I drew attention to the uncertainty of the radical cure of hydrocele by iodine injection, as usually practised. Thus, out of forty-four cases treated with solutions of iodine and potassium iodide at Guy's Hospital, I found that the treatment failed in eight cases, and that in two it failed twice.

Latterly, I believe that surgeons have recognized that the risk of recurrence is greater than that of excessive inflammation, and thus stronger solutions have been made use of—*e.g.*, the Edinburgh tincture of iodine—and some of the injection has been allowed to remain. As it is still a fact, however, that no one method of cure can always be relied upon as radical for this troublesome complaint (p. 1057), the three following will be mentioned here—*viz.* :

i. **Iodine Injection.** ii. **Injection of Carbolic Acid.**
iii. and iv. **Partial Excision.**

Iodine Injection.—Supposing the patient be healthy, not prematurely aged, and amenable to directions, the surgeon often begins with this as less painful, requiring no open wound or dressing, and finally, as necessitating much less the recumbent position.

I have already drawn attention to the frequency with which recurrence is liable to take place if dilute injections are used. Elsewhere I have written as follows : "While I believe that the absolute certainty of iodine injection has been over-estimated, yet there is no doubt that failure is too often courted by want of the following precautions :—(a) The use of a too dilute solution ; (b) Not bringing the solution in contact with the whole of the sac ; (c) Not withdrawing all the hydrocele fluid ; (d) Injecting large hydroceles immediately after they are emptied ; (e) Making use of iodine in unsuitable cases—*viz.*, hydroceles with thick walls.

* The methods of injection given below refer to hydrocele of the tunica vaginalis and to encysted hydrocele. Antiseptic incision and partial excision of the sac is applicable to all varieties of hydroceles, including the congenital.

The method of injection with iodine should be carried out as follows: The patient's bowels are cleared out for a day or two before, and it is well for him to rest with his hydrocele well supported for twenty-four hours previous to the injection. The fluid is first most carefully drawn off with a medium-sized trocar,* the surgeon then, by means of a syringe with a platinum nozzle accurately fitting the cannula, injects steadily 2 to 3 dr. of the tincture of iodine (*Edin. Pharm.*), taking care first that the cannula is well within the cavity of the tunica vaginalis. I now plug the cannula with a small wooden spigot, while the affected side of the scrotum is gently manipulated and shaken so as to bring the fluid in contact with all the interstices and folds of the serous membrane. In five or ten minutes the cannula is withdrawn, as in most cases it is quite safe to leave in the above given amount of iodine. The puncture is kept carefully closed around the cannula while this is taken out, and then closed with iodoform and collodion. A feeling of heat is noticed during the injection, sometimes amounting to sickening pain, referred also to the inguinal and lumbar regions, and the neck of the bladder. Faintness is not very infrequent, and it is thus well to tap and inject the patient while he stands at the end of a sofa, or lies down.

The after-treatment depends on the amount of inflammation. In most cases there is too little rather than too much of this. It usually appears within two or three hours, and if it be slight or delayed, the patient should be told to walk about a little, and the sac again frequently manipulated. The patient should be kept to his bed or sofa for a day or two, the scrotum supported, and plain diet given. There should be no hurry to employ ice, this being only made use of if the swelling threatens to be great. Morphia may be given freely. Within four or five days, usually, the patient may get about wearing a suspender. He should be prepared for a return of the swelling after the injection, otherwise he will be disappointed at what he considers a recurrence of his disease. The swelling, as a rule, disappears in three to four weeks.

In the case of a double hydrocele, if the patient be healthy and not advanced in years, it is quite safe to inject both sacs at the same time, but in elderly or weakly subjects, antiseptic incision will be the safest course if the patient desires an operation, otherwise an interval should be allowed between the two tapings.

Carbolic Acid.—This method was introduced in 1881, by Dr. Levis, of Philadelphia (*Boston Med. and Surg. Journ.*, 1881, vol. cv. p. 540). The following *advantages* have been claimed, and in my opinion largely substantiated: (a) It is less painful than iodine. (β) It is more certain. Thus, carbolic acid produces almost uniformly the proper degree of inflammation, neither falling short nor exceeding that needful for producing plastic lymph. (γ) There is less risk of sloughing. (δ) The patient is only kept from his employment for a day or two, and sometimes for a shorter time than this, or even not at all.

While the above advantages of carbolic-acid injection over that by iodine, especially the fact that it entails a much shorter rest and absence from business, have, in my opinion, been largely substantiated, it is certain that complications and undesirable sequelæ, while less frequent, are not so entirely uncommon as some

* By some a solution of cocaine is now injected. I prefer not to use this, if possible, so that no dilution of the iodine injection may occur.

partisans of this method would have us believe. (1) **Recurrence.**—With regard to this matter, I would point out that a large number of cases have been published as radical cures within a year or so of the first introduction of the method. Thoughtful surgeons who have seen much of radical cure of hydroceles will not need that I should refer them to the remarks which I have made on the rebellious nature of many hydroceles, and how they must be carefully watched for an extended period before a radical cure can really be claimed. It is beyond the bounds of probability that while a hydrocele will recur after careful incision and drainage (p. 1057), and even after incision and partial excision of the sac, injection of carbolic acid will be invariably and permanently successful. And it is interesting to note that in America itself, where this method has been most largely used, and where surgeons have had the largest opportunities of watching its results, they are not in entire accord as to its value.

Thus, Dr. Bull, of New York (*Ann. of Surg.*, July 1886, p. 35), in a paper recommending antiseptic incision, writes, "It is a striking fact that of the thirteen cases I have met with, two had been treated unsuccessfully in this way. As it attempts a cure by the same process as that incited by iodine, an adhesive inflammation, I see no reason to believe that it will ever yield much better results." Dr. R. F. Weir, in the discussion that followed on the reading of the above paper, said he had used carbolic-acid injections over sixty times. Occasionally relapses had occurred, not in a large proportion, however, as he could recall only four or five instances, and in those the patients were cured by a repetition of the same treatment. In three of those the injection was repeated too soon, as subsequent experience showed that a longer delay would probably have resulted in a cure. Helferich, of Griefswald (*Therap. Monatsschrift*, 1890), has tested carbolic acid injection by Lewis' method in over 30 cases, with known results in 27; 21 were cured, 6 relapsed; all of these latter, save one, being cured by a fresh injection.* (2) **Much Reaction. Cellulitis and Suppuration.**—It is right to say that in some of the cases in which this has followed on the injection of carbolic acid an excessive quantity seems to have been employed. Thus, Dr. R. Abbe (*New York Med. Journ.*, Dec. 22, 1883) reports that he injected three drachms of carbolic acid and glycerine into a large hydrocele sac, and that acute suppuration followed, requiring incision, which cured the hydrocele. He allows that the above quantity is excessive, one drachm always sufficing. Dr. Weir (*loc. supra cit.*), in one case in which the iodine treatment had failed, injected 3 drs. of carbolic acid, which was followed by the usual absence of pain, but with recurrence of the swelling in a few days, which went on to suppuration, and after incision of the sac, shreds and large masses of membrane were discharged, gangrene of nearly the entire tunica vaginalis being produced.

The above cases of Weir, Monod, and Helferich show that accidents have followed even when the amount of carbolic acid used is small. They suggest that, considering the comparatively recent introduction of this method, and the restricted number of surgeons

* Mr. Southam (*Lancet*, 1887, vol. ii. p. 515) mentions a case which recurred within the month of the injection with carbolic acid, and was then treated by antiseptic incision and partial excision of the sac.

by which it has been used, that complications are at least as frequent as after iodine injection.

(3) **Carbolic Acid Poisoning.**—Most writers have distinctly stated that this does not occur. It is certainly extremely rare, as it is probable the surfaces are sealed by the carbolic acid.

But Dr. J. Murphy, at a discussion at the New York Association (*New York Med. Rec.*, June 20, 1891), said he had known of three or four cases in which carbolic acid used in this way was followed by bad effects, especially on the kidneys. He had seen one case terminate fatally, and he could not attribute this death to anything but carbolic-acid poisoning. He did not know how much carbolic acid was used.

The Injection.—After the usual tapping, Dr. Levis, by means of a syringe which has a nozzle sufficiently long and slender to reach entirely through the cannula, injects about *a drachm (of crystals)* of carbolic acid, which must be kept liquid by a five or ten per cent. addition of glycerine or water. The former should be preferred. No more fluid is to be used for dilution than is absolutely necessary. Liquefaction by heat is inadmissible, as solidification is in this case liable to follow in the cannula. As soon as the carbolic acid is lodged in the sac, the scrotum is freely manipulated, so as to diffuse the carbolic acid uniformly. A sense of warmth is produced, quickly followed by decided numbness.*

My own experience is too limited to be of any value. Of late years I have used antiseptic incision with partial excision of the sac, and have been so well satisfied with it as to prefer to use it wherever the patient can lay up. But where this is objected to, I have used iodine and carbolic acid, but the latter only in seven cases. There is no need of Levis's special instrument. What is essential is to use carbolic acid liquefied with glycerine, not to inject more than 1 drachm, and to lodge it well within the tunica vaginalis. This may be done by means of one of the large exploring hypodermic needles, which hold 60–100 minims.†

The needle attached to the syringe is first lodged safely in the cavity of the hydrocele, which is then tapped in the ordinary way with a fine hydrocele-trocar. When the sac has been thoroughly emptied, the cannula is withdrawn, and the syringe, previously cleansed, containing the solution must be screwed on to the needle, which has been kept *in situ*, and the solution injected. However this is done the carbolic acid must be brought in as complete contact as possible with the interior of the sac, by manipulating the scrotum, turning this from side to side, upside down, &c. I have employed strapping later, as after the use of iodine. The absence

* No drops of the carbolic acid must be allowed to fall on to the scrotum, or troublesome irritation may be set up.

† I learnt the value of these in small hydroceles, as in those of the cord, or the infantile variety in boys, from the late Mr. Berkeley Hill (*Brit. Med. Journ.*, 1886, vol. i. p. 1164). Following Mr. Hill, I have also given an anæsthetic in children.

of pain and inflammatory reaction has certainly been striking, but as in none of the cases have more than a year and nine months elapsed since the injection, they must be further watched before a cure is claimed for any of them.

Antiseptic Incision with Partial Excision of the Sac.—This latter is often spoken of as excision of the tunica vaginalis. As the parietal layer of the serous membrane can alone be removed, I prefer the above title.

A. Advantages.

(1) Its greater **certainty**. While it is right to remember that no method can be absolutely relied upon as radical, and that hydroceles have recurred even after incision and partial excision of the sac,* there seems no doubt that a method which freely exposes the cavity of the tunica vaginalis, thus enabling the surgeon to deal with any morbid conditions present, which drains the cavity entirely with absolute certainty, and thus leads to rapid shrinking of its walls, leaves a much smaller secreting surface to be altered. A method which further removes a large part of this secreting surface must *à priori* be surer than those methods which do their work as it were in the dark, in which the drainage must needs be imperfect, the quantity of the irritant employed necessarily limited, it being thus always left doubtful how far the injection has been weakened by dilution or chemical change, and how far folds of the inner surface of the tunica vaginalis have escaped inflammation at all. On this account I prefer to make use of partial excision in all cases where the general condition of the patient is satisfactory, and where he is willing to lay up for a week in bed and two weeks on the sofa.

The **cases** to which this method appears to me to be **especially suitable** are those where (a) iodine or carbolic acid have previously failed, (β) where the sac is very large or has very thick walls. Where the sac is simply very large, but not much thickened, it can be safely and successfully injected, if this is preferred, by tapping first and then allowing only an interval of two or three weeks to elapse before the sac is injected. But if the walls are much thickened, there are the risks that after tapping they cannot collapse readily, and so be brought in contact with the irritant, and, while in a sac like this it is always uncertain if the due amount of inflammation will be secured, there is also a risk that owing to the little vascularity of a thickened sac sloughing may take place. (γ) Where on account of ill-health or age the risk of

* On this point a valuable paper by Mr. H. Morris, followed by an interesting discussion (*Med. Chir. Soc.*, Feb. 28, 1888), should be consulted (*Brit. Med. Journ.*, March 3, 1888). Two cases of recurrence after partial excision of the sac were related. Mr. Pollock mentioned one even more extraordinary. This recurred repeatedly—*i.e.*, after two injections with iodine, the introduction of a silver wire seton and “ample suppuration”: finally, the sac was laid open and lint inserted for a fortnight. The hydrocele again recurred and the patient declined any further treatment than simple tapping.

inflammation after injection of an irritant is especially to be dreaded. (δ) Where the surgeon is desirous of exploring the sac of the tunica vaginalis, as in cases where enlargement of the testis of a doubtful nature coexists with hydrocele, and does not yield to ordinary treatment, where a hæmatocele has supervened on a hydrocele, or in the much rarer cases of loose bodies in the sac of the tunica vaginalis. (ε) Where several hydroceles co-exist—*e.g.*, either double hydrocele of the tunica vaginalis, or a vaginal and encysted hydrocele. (ζ) In certain cases of hydrocele complicated with hernia—*e.g.*, (1) in young subjects where a radical cure of both is desired, (2) in much older patients, where the hernia is irreducible, where, especially in unhealthy patients, there is a risk of the inflammation set up by the injection extending to the sac of the hernia. (η) In cases of congenital hernia a careful incision with antiseptic precautions will be safer than any other method of radical cure if the pressure of a truss for the obliteration of the communication with the peritonæal sac cannot be persevered with. And the same course will be wise in the case of encysted hydroceles of the cord, when their important surroundings, mobility, and their difficult fixation before injection are considered.

(B) The **disadvantages** of this method must next be considered. (1) As pointed out in my paper in 1877, it undoubtedly involves more **trouble** than that by injection. While it can be completed in a quarter of an hour, an anæsthetic will be required, and there is also the trouble of the subsequent dressings, and there is also more need of absolute rest. Thus the patient will be confined to his bed for a week or ten days, and after this will have to keep quiet on a sofa or in an armchair. (2) With regard to the amount of **subsequent orchitis, pain, swelling, &c.**, I am of opinion that this varies but not as much as after iodine injection. In the early days of this method—the Schnitt method of Volkmann—when after incision of the tunica vaginalis this cavity was carefully plugged with strips of aseptic gauze to promote changes in the serous membrane, orchitis to a painful degree was not uncommon; but of late years when, after incision of the sac, the parietal layer of the tunica vaginalis is gently detached from the scrotum and cut away close to the epididymis and the testis, the cut edges being stitched to the cut edges of the skin, I have been extremely struck by the very small amount of pain suffered, in spite of the disturbance, and the handling entailed of the parts concerned. (3) With regard to the **duration of the after-treatment**, this is in favour, but not so distinctly as would appear at first sight, of the injection method. With regard to the injection of carbolic acid, this is most certainly so (p. 1056). Iodine has also an advantage in time less clearly marked. Thus, after injection with carbolic acid, the patient may perhaps not have to lay up at all. After forty-eight hours he will probably be able to follow his employment if not an arduous one. After the use of iodine the patient will probably be able to get about after the first week. But these dates are only

approximate; even with regard to carbolic acid it is impossible to read through a large number of cases reported by American and other surgeons without seeing that inflammatory reaction, crippling to locomotion, does occur more frequently than would be gathered from the reports of those surgeons who have advocated it most strongly. And again, as is shown above, while carbolic acid is extremely convenient, it is clear that there is no absolute certainty about it, and that repeated injections have been called for in many cases. After iodine injection the scrotum is often not its natural size, and the patient not free from all encumbrance till between the second and the third week. By the latter date, after antiseptic incision, the patient may get about, though a superficial granulating surface may very likely be left for seven or ten days later. (4) As to the risks of hæmorrhage, cellulitis, and sloughing, which have been described by some writers, I can only say that I have never seen them in an experience of twenty-one cases of antiseptic incision, and of antiseptic incision and excision of the sac. (5) Of the complication of orchitis I have already spoken. (6) Another condition which may cause temporary discomfort, and which I saw several times in my cases, when using the carbolic spray and gauze, is **erythema** and redness of the scrotal skin and about the wound. This always yielded to the use of green protective and salicylic cream. Since using dilute hydr. perch. irrigation and iodoform gauze dressings, I have been very little troubled with the above complication.

The Method of Antiseptic Incision with Partial Excision of the Sac.—The patient having been prepared for the operation, the parts, shaved and well cleansed with soap and water used with a flannel, and then washed with a dilute solution of carbolic acid or mercury perchloride,* ether, or A. C. E. is given. The surgeon, the scrotal tunics being made tense by his left hand or by an assistant, incises† them down to the hydrocele, from the top to the bottom of the swelling, and then before opening this arrests any bleeding points by applying Spencer Wells' forceps. The hydrocele is then opened sufficiently to admit a finger, which makes out definitely the position of the testicle; the tunica vaginalis is then freely but carefully slit up with blunt-pointed scissors. As when the hydrocele is

* As it is of the utmost importance that there should be no irritation, or erythema set up, which may cause discomfort and subsequent restlessness and also suppuration and slowness of healing, the antiseptic solutions which are all irritants, should be used both before or during the operation, as dilute as is safe to the very delicate scrotal skin—*e.g.*, carbolic acid 1 in 30, and mercury perchloride 1 in 4000. For the same reason no scrubbing with a nail-brush is advisable. These may seem trifles, but they may have a very important bearing on the after result. To promote relaxation of the dartos and prevent contraction, and thus curling in of the skin, warm solutions should be used.

† The position of the testis should first be made out by translucency. The more showy step of opening the hydrocele at one cut might endanger the cord and testicle.

opened the fluid escapes with much force, the sac at once collapses into folds, and scissors will be found preferable to the knife. The incision into the tunica vaginalis should be as free as is safe, for a free incision will at once admit of rapid removal of the parietal layer, and a thorough examination of the recesses of the serous sac. If a small one only is made, owing to the contraction of the dartos, the above steps will be found impossible. Further, a large incision is, by the above, soon folded into a little space, and heals as quickly as a small one. Spencer Wells' forceps are then applied to every bleeding point in the cut edges of the sac. There should be no hurry to tie these off, as many of the vessels will be closed by the sutures which unite the cut edges of the tunica vaginalis to those of the skin. The forceps on either side serving to widely open out the wound, the testis and epididymis are examined for any cysts, sometimes present about the head of the latter. The inner surface of the tunica vaginalis is carefully scrutinised for any fibrous bodies attached or loose in any of its folds, or for false membranes and thickenings. As any of these may, by keeping up irritation, lead to a recurrence of the hydrocele, they should be dealt with, the cysts being snipped away after ligature of their pedicles with fine catgut. The parietal layer of the tunica vaginalis is now gently detached,* or peeled away from the scrotum as far as is safe—*i.e.*, close up to the epididymis on the outer, and to the back of the testicle on the inner side. Along these limits it is snipped away with scissors, and forceps applied to all bleeding points.

If any false membranes are now present over the testicle and epididymis or the small part of the parietal tunica vaginalis that remains, these are to be detached with a sharp spoon. The bleeding which follows may be smart and require very hot solutions of mercury perchloride, or firm pressure with a sponge. Different ways of closing the wound have been employed. In all my cases I have followed Bergmann, and having cut away the serous sac freely, have sutured its edges to those of the skin with stitches of fine catgut. But I have gone farther, knowing how rebellious some hydroceles are (p. 1057), and I have, after thus suturing the tunica vaginalis and skin, wiped over, once, and very lightly, what is left of the parietal layer of the latter and the visceral layer on the testicle, with silver nitrate. I have not found that this has been subsequently followed by orchitis or pain.

The skin and tunica vaginalis having been carefully sutured with the carbolised silk, horsehair, or chromic gut, and the remaining tunica vaginalis very lightly wiped over with a stick of silver nitrate or, if it is preferred, pure carbolic acid, and all bleeding carefully arrested, it only remains to dust a little iodoform over the wound. dry this out most scrupulously, and apply the dressings. What-

* Great care must be taken here; rough handling will be very likely to lead to cellulitis and suppuration. There is usually very little bleeding.

ever material is used care must be taken that the dressings should supply the following conditions—viz., they must be aseptic, duly compressive, and unirritating. I have been in the habit of using green protective and iodoform gauze, secured in place by firm and even bandaging with a double spica. While this is applied, care must be taken that the scrotum is kept well up on to the pubes. This is a cardinal point, and must be attended to not only now, but later on, at and after each dressing. It prevents œdema, bagging, and inflammation, and thus also pain, and hastens rapid repair of the wound. When the dressings are *in situ*, a pad of carbolised tow should be kept over the anus, to prevent flatus or fæces contaminating the closely adjacent wound. The changing of the dressings must depend on the restlessness of the patient, his ability to put up with irksomeness and discomfort, any action of the bowels, the condition of the temperature, &c. On the third or fourth day most of the sutures uniting the skin and tunica vaginalis should be cut and removed; by the fifth or seventh day the patient may get on to a sofa, and by a date varying from the fourteenth to the twenty-first day he may usually begin to get about, with a suspender, and the small remaining wound protected by a sealed dressing (some sal alembroth or iodoform gauze sealed on with collodion) changed every few days, or by one of iodoform or resin ointment. As the repair with aseptic wounds is rapid, but often filamentous and weakly, I advise the use of a suspender for six months or a year after the operation, and longer if occasions arise for hard exercise such as riding, &c.

VARICOCELE.

Indications.—While palliative treatment will be sufficient in the great majority of cases, if, at the same time, due attention is paid to the general health, the occupation and habits of the patient, and, where this is required, to his sexual hygiene, an operation will be justifiable in the following cases:

(1) Where the patient is precluded from entering one of the public services, or any occupation involving much activity in the upright position. Thus, out of the twenty-eight cases in which I have operated, twelve were private cases, of which nine were applying and passed into the army and navy, and one was a medical man, operated upon for double varicocele; of sixteen hospital cases, one was desirous of entering the police and subsequently did so; one was a goods-guard on probation and found that a large left-sided varicocele threatened to spoil his prospects, the aching pain, which invariably followed the jumping in and out of his brake-van, being only relieved by the patient's lying down, and being inevitably brought on again by the next station. This man stopped me on London Bridge some five years after, to say that he was in regular employment as a goods-guard married, and the father of two children. Five others were shop assistants, and two were gardeners. (2) In any case where the varicocele persists or steadily increases, in spite of treatment, and where it is accompanied with much distress, annoyance or pain, or where it interferes with some justifiable pursuit, such as riding; (3) where the surgeon has satisfied himself that the testicle is under-

going atrophy; (4) where the varicocele is accompanied by frequent seminal emissions and much mental misery. In the two last given indications, great caution must be shown before operation is resorted to, and the last is the most doubtful of all. Where the patient is clearly hypochondriac, or a monomaniac in genital matters, no operation is, of course, to be thought of. It is certain to be a failure.

The choice of operation is a very large one, but as I consider that one alone has been proved to be alike efficient and simple, I shall not occupy my space with an account of any others, or with the history of the operation. Like so much else in operative surgery, the only efficient and simple operation for varicocele dates to the great discovery of Sir J. Lister.*

Antiseptic Excision.—This operation, performed with the parts well in sight, has the very great advantage of allowing the surgeon to carry out each step with precision, to include what he thinks safe, and no more; it does away with the risk of transfixing a vein, and its possibly disastrous results of septic thrombosis; it requires very few and simple instruments; while Sir J. Lister's teaching has enabled us to perform it without the risks of hæmorrhage, cellulitis and blood-poisoning, which were so terribly frequent in operations on veins performed before his day

For a few days before, the bowels should be kept well open, and the diet should be light and limited. The parts should be shaved, and thoroughly cleansed with soap and water, and then lotio hydr. perch. 1-4000 (p. 1059). It is well to perform the cleansing a few hours before, and to keep a compress wet with the above lotion on up to the time of the operation. The patient having been anaesthetised with ether or A. C. E. mixture, the vas deferens is isolated, and either kept so by two fingers of the left hand, or handed over to an assistant, who stands on the opposite side to the surgeon. In either case the latter makes the veins prominent by grasping the affected side of the scrotum and protruding the varicocele. An incision, about one inch and a half long, is then made over the now prominent varicocele, care being taken to keep well above the level of the tunica vaginalis.† With one or two strokes of a keen-edged scalpel the packet is exposed and carefully opened. The surgeon then passes a steel director, first at the upper and then at the lower angle of the wound through the packet so as to leave about a third of the veins behind it; along the director, which thus keeps a track open and easily found, an aneurism needle or eyed-probe, carrying a medium-sized ligature of sterilised chromic gut, is passed. This is then tied firmly round the included veins. If the incision has been made one inch and a half long, and the upper and lower angles of the wound are well retracted, no difficulty will be experienced in placing these ligatures near enough to the external abdominal ring and testicle respectively to ensure removal of a sufficient extent of the enlarged veins. After each of the ligatures, upper and lower, has been tied securely and cut short, a pair of scissors is run along the director, and the packet is cut through about a quarter of an inch from each ligature. The portion of varicocele thus included is then removed by carefully clipping it out with a pair of scissors; any cross branches which may now be divided are secured with fine chromic gut. An extremely important

* Mr. Howse drew attention to the method of aseptic excision in varicocele (*Guy's Hosp. Reports*, 1887, vol. xxiii. p. 408).

† In some cases, where numerous veins overhang the testicle itself, the lower ligature should be placed as low as possible. If, in the earlier incisions, the tunica vaginalis is opened, the opening should be taken up with Spencer Wells' forceps and tied up with fine catgut, or it may be left without treatment. If the wound runs an aseptic course, this complication will give very little trouble.

step comes next. With a sharp-pointed half-curved needle, carrying medium-sized chromic gut, the surgeon brings into accurate opposition the two ends of the stumps, the ligature being passed through the centre of each stump close to the corresponding ligature. As it is tightened, an assistant with a sharp-pointed probe, brings the cut ends of the veins on the face of each stump snugly and precisely together. The object of this most important detail is to permanently shorten the cord, and to restore the natural suspension of the testicle. It would obviously be quite impossible in any subcutaneous method. I have practised this detail since 1887, but as Mr. Bennett was the first to draw attention to this step (*Lancet*, Feb. 1891), the credit of showing the importance of it must be his. A little iodoform having been dusted in, the sutured cord is replaced in the bottom of the wound. When the skin is much relaxed, I finish the operation by removing widely, by two elliptical incisions, the skin on either side of the small wound which has been made, the apex of the incisions being placed well up over the external ring. I think it well to adopt this step, as I believe it helps to brace up the relaxed parts: but it is not of the least use by itself, and it is much less needed now if the above given precaution of ligaturing together the vein-stumps, and thus shortening the cord, is taken. And the same may be said of another step which should be taken before the close of the operation—*i.e.*, ligature and removal of any very enlarged scrotal veins, a step which I always adopt when the patient's attention has dwelt on these. The whole wound, superficial and deep, is then carefully scrutinised, and every bleeding-point being secured is thoroughly dried with a sponge that has been well wrung out. The edges of the wound are carefully adjusted with silk or horsehair sutures, the tendency to inversion being borne in mind. Dressings of green protective and iodoform gauze are then applied, due facilities being provided for the patient's micturition. In securing the dressings *in situ*, care should be taken to keep the scrotum well up on to the pubes by bringing the turns of the spica from below upwards and not in the reverse direction. I generally change the dressings at the end of the third day, immediately after the first action of the bowels, and again at the end of the first week, to remove alternate sutures. At this date the patients may get on to a sofa, but I insist on their maintaining the recumbent position for two or three weeks. Aseptic union, forming quickly and without the medium of granulations, remains weak for a long time. If the stumps of the cord have been sutured together there is much less need for the patient to wear a suspender afterwards; but to give the operation every chance, and to save all drag and tax upon parts which have very recently united, I generally advise that a suspender be worn for three months. In addition to the support which I believe to be advisable while the sutured stumps of the cord are being firmly knit together, I am of opinion that the continuance of support to the parts for a while prevents a too rapid melting away of the little nodular mass, which, callus-like, marks the seat of the operation.

The points to which I should attach most importance in the operation are maintenance of strict asepsis throughout by irrigation with *lotio hydr. perch.* (1-4000), suturing together the two stumps, and so shortening the cord and providing for suspension of the testicle; arrest of all hæmorrhage, thorough drying out of the wound, the use of a horsehair drain if the parts have been much disturbed, and the careful application of an antiseptic dressing, so as to keep the scrotum well up on to the pubes. I look upon these details as most necessary, if rapid healing is to be made certain of, and cellulitis, epididymo-orchitis, and hydrocele prevented.

Mr. Bennett (*loc. supra cit.*), in his operation for varicocele, advocates some different and, in two instances, far more radical steps; thus (*a*), he does not open the general sheath immediately surrounding the veins, as by leaving it intact he makes certain of passing the ligature around *all* the affected veins, as

none of these ever lie outside the fascia. Furthermore, the fascia, if not opened, better carries the weight* of the dependent testicle. (β) Mr. Bennett considers that the view generally held, that the spermatic artery is displaced with the vas deferens and thus kept out of the way, is a mistake; in reality the artery remains with the veins. Furthermore, Mr. Bennett holds that the artery is usually and may always be safely divided with the veins, for as long as the wound remains aseptic, the artery to the vas deferens, "and some outlying branches of the spermatic artery, one of which sometimes comes off high up and so may easily escape division, are sufficient to carry on the blood supply to the testicle, and to prevent any risk of atrophy."

While Mr. Bennett's plan is justified by the results obtained by his own practised hands, I feel that, writing as I am for those who may not have had many opportunities of operating for varicocele, I ought to point out certain grave risks which I consider to be at least possible, if the above teaching is widely followed.

First, as to division of *all* the veins, I will say at once that perhaps I am prejudiced unduly by the unfortunate result of one case, out of my twenty-one, which I mention below. While I admit that recurrence of the varicocele may be brought about by removal of too few of the veins, I feel strongly that inclusion of all of them in the ligature involves a much graver risk. Further, I cannot agree with Mr. Bennett that it is safe to trust to the artery of the vas, or branches of the spermatic which may come off sufficiently high up to be available, and some small unimportant anastomotic branches passing from the sub-vaginal tissue. Mr. Bennett allows that these vessels are small and delicate, and points out that any inflammation about the parts may be sufficient to choke them. sloughing or wasting of the organ following as a necessary result.

Thus, while in no way criticising Mr. Bennett's modifications of the operation when practised by himself, I strongly advise my junior readers to make use of the simpler and very efficient method given at p. 1062.

The **chief risks and causes of failure in the operation** are as follows:

I. Sepsis and its Results.—The risk of these was always present with the old subcutaneous operations, however modified; it is by no means to be lost sight of with the open operation performed with the advantages of modern surgery. A good instance of sepsis and its dangers is recorded by Mr. H. Lee (*Clin. Soc. Trans.*, vol. i. p. 73). Here erysipelas, repeated hæmorrhages, sloughing of the skin of the scrotum and penis, and multiple abscesses, followed on Mr. Lee's operation of subcutaneous division of the veins between two pins secured with figure-of-eight sutures. Mr. Lee also mentioned cases in which abscesses, localised sloughing of the skin, and, on two or three occasions, arterial hæmorrhage, controlled by introducing a third pin, had happened in his experienced hands. It is certain that other operators have not been so candid.

II. Inclusion of too many Veins.—That this is a real danger is shown by a case of mine which I published (*Syst. of Surg.*, vol. iii. p. 571). The patient here had a double varicocele, that on the left side being truly colossal. It was my third case, and was operated on with precisely the same precautions as to the vas and to the maintenance of asepsis as those given above (p. 1062), save that the carbolic spray was used instead of irrigation. Owing to the huge size of the varicocele, three bundles of veins were removed, and even then a large number appeared to be left, the varicocele being a quarter of its former size. The case did well up to the eighth day, when the wound opened, and the lower half of the testis, evidently gangrenous, presented itself. This was cut away after the application of a chromic gut ligature. Though, at the close of the

* This is rendered of less importance by the suture which unites the vein stumps.

operation, it did not appear that too many veins had been removed, such must have been the case. I am certain no injury was inflicted upon the vas deferens; throughout the operation this was entrusted to very careful hands, those of Dr. B. N. Rake, at that time my dresser, lately of Trinidad, and one of our chief authorities on leprosy, whose untimely death has cut short so much excellent work.

III. Recurrence of the Varicocele.—I am of opinion that if operation-cases were more thoroughly followed up afterwards, this sequela would be found to be more common than is thought to be the case. It is especially likely to follow the subcutaneous method, where the patient is allowed to get up, or is hurried out of the hospital to make room for another case as soon as the wound is healed. To prevent this risk of recurrence Mr. Bennett lays stress on the need of removing the entire plexus of spermatic veins. As I have been unfortunate enough to meet with a case in which, in spite of care taken, too many veins were ligatured and removed, I cannot agree with Mr. Bennett (p. 1064). Another instance of what appears to be recurrence, but which is really an escape of the lower part of the spermatic plexus, may be due to the upper ligature being applied too low down (Bennett). In this case the part of the plexus between the upper ligature and the external ring remains full, and may give trouble for a time, though it gradually shrinks.

Insecure knotting of the ligature, or not using reliable material* may, of course, lead to recurrence after any method in which ligatures are used but the veins are not also divided.

CASTRATION (Fig. 293).

Indications.

I. *Growths of the Testicle.*

Diagnosis of Malignant Disease of the Testis.—As the records of surgery contain many instances of mistakes under able hands—hæmatoceles removed for malignant disease, and malignant disease opened for hæmatocele, a few hints may not be out of place here on the subject of castration.

Contra-indications.—Castration should not be performed when the cord is extensively involved; when masses can be felt deep seated in the iliac fossa and lumbar region; when there is any evidence that the liver or lungs are involved; or when the jaundiced sallow tint, and rapid emaciation point to the disease having become general. In cases at all advanced, though the patient might be rid of an encumbrance, the operation would be very liable to be followed by a low form of peritonitis, or, before the wound was healed, swelling would probably appear in the inguinal region, and the growth soon fungate through the wound.

The following are the points on which most reliance may be placed:

Continuous, and often quickly progressing solid enlargement of the testicle or epididymis without inflammation. Sometimes this progress is much slower; occasionally it may seem to be in abeyance, but careful watching with frequent examinations (and these are the key to obscure cases) will show that the enlargement is progressing in spite of treatment. Failure of well-directed treatment: where the swelling is small, still oval in shape, and smooth and firm in outline, a brief trial of mercury or potassium iodide may be made, combined with carefully applied Leslie's strapping, but where in a week there is no result, or where the

* Mr. Bennett prefers kangaroo-tail tendon ligatures.

case is of longer duration, and delay will very likely be fatal, an exploratory incision with antiseptic precautions, followed, if need be, by immediate castration, will be the wiser course.* Consistence.—This is rarely for long the same all over the swelling. Even if a firm, slow growth seem uniform and recall orchitis, a careful examination will usually find one or two spots which are more elastic than the rest. Usually the softening at places where cystic or degenerative changes are taking place is well-marked. But it may require somewhat prolonged watching to detect one or two at first lowly rising projections or bosses which foretell that the tunica albuginea is becoming thinned at this spot. Of enlargement of the cord,† fulness of the scrotal veins, adhesion of the scrotal tunics, increasing aches and painfulness I say nothing, as they are evidence that the disease is entering into a later stage.

An exploratory incision is to be preferred to the use of a trocar, as being more certain to give information.

A trocar may enter a solid part or withdraw some scanty mucoid fluid. Sometimes the amount of blood which flows through the cannula of a trocar thrust into a testicle, the subject of rapidly growing malignant disease, is so great as to lead to the supposition that it must be a hæmatocele. In such cases, however, the diminution of the swelling is not so proportionate to the flow of blood as it would be in hæmatocele. Furthermore, the blood is usually bright, not dark and altered as in hæmatoceles.

Prognosis.—It will be seen that the prognosis is always grave, extremely so in the softer and more rapid growths. Kocher goes so far as to say with regard to these that no case of really permanent cure of encephaloid carcinoma is known. In medullary sarcomata, especially in children, the prognosis is almost as gloomy. But while the above opinion is only too true of the majority of cases, a sufficient number have been recorded to show the benefit which may follow on castration, even in the soft forms of sarcomata. Mr. Meade, of Bradford, removed in 1846, the testicle of a patient, aged forty, for a swelling which had lasted about nine months (*Lond. Med. Gaz.*, vol. xlv. p. 702). Nine years later, the patient remained free from any return of the disease. In the Museum of St. George's Hospital is a specimen of a testicle converted into a mass of soft malignant growth, with large caseating patches, which Mr. Cæsar Hawkins removed from a patient, aged forty-five, the enlargement having lasted two years. Twelve years later this patient was alive, and in good health. In the *Med. Times and Gaz.*, 1886, vol. ii. p. 287, a case of Mr. Cock's is mentioned in which a patient remained in good health for six years after castration for "medullary cancer," being then lost sight of in consequence of his emigration to Australia. While these cases are most encouraging, I fear they are exceptional. It will be noticed that in one a swelling had lasted nine months, and in another two years. If it be thought that such cases show that no limit can be fixed beyond which castration must be useless, the following must be remembered. First, is it possible that the earlier enlargement was, for some time at least, inflammatory? Secondly, as a rule, in the softer sarcomata, enlargement of the lumbar glands will be present by the end of the first year of the growth, and often earlier.

As a rule, the retro-peritoneal glands and viscera will be involved by extension and secondary deposits within six months of the time of castration. And this result is the more disappointing because the testicle, a free, floating organ, and

* I may warn my younger readers of the temporary improvement which potassium iodide sometimes seems to bring about even in malignant swellings.

† I quite agree with Mr. Butlin (*loc. supra cit.*) that early enlargement of the cord is met with in inflammatory conditions of the testicle, and is, here, a contra-indication to malignant disease.

one placed independently in a fibrous capsule, appears to be remarkably favourably placed for the radical removal of malignant disease. The intimate association of the organ with the lymphatic system, both within itself and with those within the abdomen, and the facility with which these are early implicated, handicaps us terribly here.

But if, as happens most frequently, the disease occurs elsewhere after castration, a useful life may yet be prolonged, the patient, rid of a wearisome encumbrance, is made more comfortable, and, towards the close, death from internal deposits of malignant disease is not accompanied with the same distress both to the patient and those around him as when the disease is situated externally. In proof of the temporary benefit of castration, Mr. Curling (*Diseases of the Testis*, p. 342) relates the case of an eminent barrister, who, for two and a half years after the removal of a testicle for soft cancer, was able to continue the practice of his profession to the great advantage of his family, death ultimately taking place from extension to the lumbar glands.

II. *Tubercular Testicle*.—I am of opinion that castration should be performed much earlier in this disease than is usually the practice. Natural cures are so few, dissemination is so frequent and so grave, whether to bladder and kidneys, vesiculæ seminales, or prostate,* or to the lungs,† while, on the other hand, castration is nowadays, so safe an operation, that it should not be deferred.

I have only space to mention briefly the **indications**: (1) Where erosion fails in lesions still limited to the epididymis. If one or more discharging fistulæ still persist here, especially if the patient is not in a position to avail himself of a repetition of erosion at the seaside, castration should be performed, slight as the mischief appears to be, especially if they affect the patient's health or interfere with the outdoor exercise so necessary in these cases. It is only too probable that minute deposits are already making their way into the testicle itself by spreading along the rete, a condition impossible to recognise by external manipulation. (2) Where after erosion any fistula has healed, but careful watching of the patient, always to be insisted on, detects the existence of, it may be, slight but persistent swelling in the scrotum, with night sweats and loss of flesh. These may point to mischief in the remains of the sexual gland, and not necessarily to disease in the prostate, &c., or in the lungs. (3) Where the body of the testicle is involved. When this remains enlarged, and liable to attacks of inflammation, castration should be performed. (4) Where the testicle remains atrophied and riddled with fistulæ, one or more

* Early phthisis should not interfere with removal of a tubercular testis which resists treatment and prevents the patient getting open-air exercise, and weakens his health by discharge. Owing to the condition of the lungs, chloroform should be here given, instead of ether.

† Tubercular disease of the prostate is a source, usually, of such extreme misery, that any existing cause in the testis should be removed very early. Moreover, from what we have learnt from castration in enlarged prostate (p. 1068), removal of tubercular testes may prevent or greatly delay deposit of tubercle in the prostate.

of which persist in discharging, removal of a useless and dangerous organ should be practised. (5) When a hydrocele* is present, especially if purulent.

III. *Syphilitic Testis*.—Here, owing to the specifics which we possess, castration is much more rarely called for. The indications can readily be judged of from those above given.

IV. *Old Hamatocele*.

Indications.—Failure of previous treatment, especially in a man of middle life whose activity—*e.g.*, in riding—is much interfered with.†

V. *Retained Testis*.

Indications.—1. When such a testis is the seat of malignant disease. 2. When it seriously cripples the patient by the recurrent attacks of inflammation associated with it. 3. When a co-existing hernia cannot be kept up by a truss, owing to the presence of the testis.

VI. *Enlarged Prostate*.

This operation has of late years been much resorted to, chiefly through the work done by Prof. J. William White,‡ of Philadelphia (*Ann. of Surg.*, 1893 and July 1895).

The following are the chief of Prof. White's conclusions :

(i) Clinical experience shows that in a very large proportion of cases (87 per cent.) rapid atrophy of the prostatic enlargement follows the operation, and that disappearance or great lessening of long-standing cystitis (52 per cent.), more or less return of vesical contractility (66 per cent.), amelioration of the most troublesome symptoms (83 per cent.), and a return to local conditions not far removed from normal (46 per cent.), may be expected in a considerable number of cases.

(ii) The mortality is 18 per cent. If patients are operated upon under surgically favourable conditions—*i.e.*, before the actual onset of uræmia, or before the kidneys have become disorganised by backward pressure and infection—Prof. White thinks that the mortality will be only 7·1 per cent. The following appear to be some of the chief causes of a fatal issue. (1) Sepsis. This is very likely when it is difficult to prevent occasional dribbling of urine. (2) When mania or mental aberration follows. This has

* On the subject of tubercular hydrocele, of the influence of coexisting disease in the vesiculæ seminales, prostate, and lungs, on castration, I must refer my readers to chapter vi. of *The Diseases of the Male Organs of Generation*.

† The frequency with which malignant disease follows on repeated injury and irritation of the testicle is well known (Rindfleisch, *Path. Hist.*, vol. ii. p. 197).

‡ Ramm, of Christiana, seems to have been the first to perform the operation (*Centr. f. Chir.*, Sept. 2, 1893), but it is to Dr. White that our profession is indebted for first collecting and publishing with unmistakable clearness the evidence, clinical, pathological and experimental, which would justify a resort to this operation.

followed in such a distinct proportion of cases* that it must always be reckoned with. (3) Results of kidney failure, a complication always present in these cases, and especially to be feared when the operation is called for in long-standing and advanced cases of enlarged prostate. In such, the operation will be considered by the friends to be the actual cause of death; in reality it merely fails to save life.† (4) Causes of death, common to any operation performed in the aged, such as hemiplegia, and cardiac failure.

(iii) Comparison with other operative procedures. Compared with prostatectomy, the very much smaller risk, the greater simplicity, ease, and quickness of castration, the far smaller amount of anæsthetic, are too obvious advantages of castration to need more than mention. As to drainage, castration does away with the inconveniences of any fistula, and the noisome leakage which may be inseparable from it. On the other hand is the repugnance which so many men, even when well on in life, feel towards parting with their testicles, a repugnance which we shall often have to meet, and which will frequently baffle us, but one for which the patient alone must be responsible, when it has been clearly put before him how, having advancing enlargement of the prostate, he stands on the brink of a precipice, and that it requires very little indeed to send him over.

(iv) As to unilateral castration, Dr. White considers the evidence at present contradictory, and the operation worthy of further investigation. There is no doubt that in some cases it has been followed by unilateral atrophy of the prostate, and in two cases at least, by very marked improvement of symptoms.

(v) As to ligature or division of the vasa deferentia, Dr. White's experiments on dogs have shown that in nearly every case there was commencing and considerable loss of weight of the prostate. These results appear anomalous and require confirmation.

(vi) Ligature of the vascular constituents of the cord, or of the whole cord, produces atrophy of the prostate; but in Dr. White's experiments only after first causing disorganisation of the testes.

The cases to which, in my opinion, the operation is most called for, fall into two groups. (A) *The more urgent.* Where (1) previous appropriate treatment, carefully carried out, has failed; (2) where there have been one or more attacks of retention; or (3) where hæmorrhage has taken place. In either case the peril of cystitis, too often fatal here, is enormously increased: (4) Where there is inability to micturate, or where this is painful and frequent; (5) where the passage of the catheter is increasingly difficult with the risks of hæmorrhage, formation of false passages, &c.; (6) where the prostate is soft and elastic, not densely hard and fibrous—in such cases marked relief may be expected. Of course, the

* Thus it was noticed in four out of six cases published by Dr. Faulds, of Glasgow (*Brit. Med. Journ.*, 1895, vol. i. p. 974).

† In Mr. H. Fenwick's words (*Med. Ann.*, 1896, p. 508). "There is every reason to believe that unsuitable and unfavourable cases have been chosen in the first wild rush which is so unreasonably made at every innovation. Uræmic and even dying patients have been castrated."

greater the power of voluntary micturition which remains, the more natural the urine as to urea, sp. gr., albumen and sugar, the greater the rallying power of the patient, and the clearer the mind, the better the prognosis. (B) *Less urgent cases.* Here the operation is prospective and preventive. The patient is younger, the power of voluntary micturition is still good, there is no cystitis, but palliative treatment fails to relieve the frequent disturbances at night, and hæmaturia has begun to occur at intervals. Here the surgeon is abundantly justified in advising the operation as a preventive of worse things which are certain to come. The operation will not be often accepted here, but it is in such cases that it will give the best results.*

As to the amount of relief which we can promise our patients, we shall do well to be cautious while hopeful, deciding each case by itself very carefully, especially as regards these two factors, (a) the amount of voluntary micturition and control which this operation will restore must largely depend upon the condition of the bladder, how far long-standing cystitis or habitual use of the catheter have damaged its walls, replacing the muscular with fibrous tissue, and converting it into an inelastic thick-walled sac. (β) The state of the prostate. The more vascular, the softer, the more rich in glandular tissue this is, the more decided will be the shrinking that follows castration. On the other hand, the denser and more fibrous the gland, the longer delayed certainly, and, perhaps, the less marked will be the benefit.

Operation.—I have nothing to add to the account fully given below, save that both testicles should be removed through one incision in the scrotal raphe. As soon as the superficial fascia is divided, cutting a little to each side will admit of each testicle being quickly shelled out. Each cord should be divided immediately above the testicle, and the whole operation conducted with as little disturbance of the parts as possible. This method leaves only one wound to heal, a point of some importance in broken-down patients, where the feeble mental power may lead to restlessness, disturbance of the dressings, sepsis, &c. In those cases where there is dribbling of urine and the scrotum is liable to be wet, the usual incision should be made on one side, and both testicles removed through this wound. The patient should then be turned on to his other side, so that the penis hangs away from the wound, and the dressings well protected with jaconet.

Much rarer indications are:—VII. *Insanity, chronic epilepsy, &c., kept up by onanism.*† VIII. *Injury.* IX. *The radical cure of hernia—i.e.,* when the operation cannot be completed without removal of the testis, owing to the firm adhesions of the sac to the cord, especially when this occurs in a patient approaching middle age. It is always well, here, to obtain leave for castration.

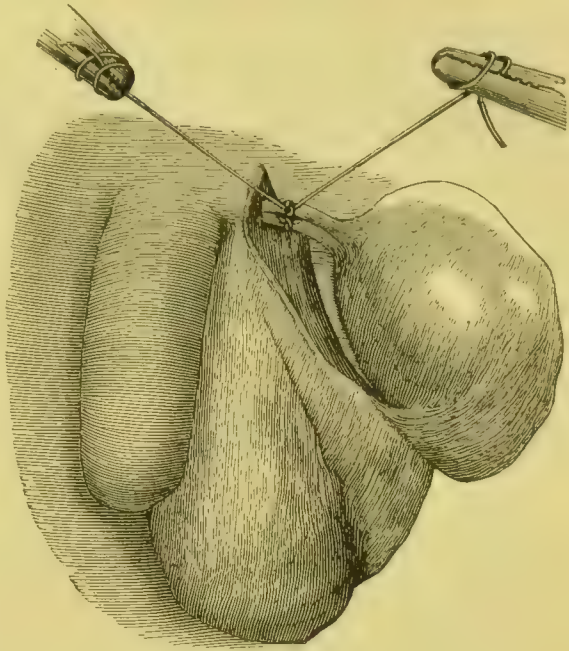
Operation (Fig. 293).—The absence of any hernia on the side operated on having been ascertained, and the parts duly shaved and cleansed, the surgeon protrudes the testicle with his left hand

* It so happens that while I have advised the operation in eight or nine cases, the two in which it was accepted belong to this, the prospective or preventive class of operation. The operations have only taken place while these sheets are passing through the press. The first, aged sixty-six, was sent to me by Dr. Ingle, of Cambridge. There had been three severe attacks of hæmaturia. There was no cystitis, and voluntary micturition was fair. Two weeks after the operation nocturnal irritability had fallen from "10 or 12 times to twice," and the power of expulsion was much more "free." The second promises equally well.

† On these subjects I may refer my readers to chap. xii. p. 477, of *The Diseases of the Male Organs of Generation.*

so as to make the overlying tissues tense, and divides them from the external abdominal ring to the bottom of the scrotum, so as to ensure free and easy drainage. In cases where the skin is involved by a growth, or ulcerated by a hernia testis, two elliptical incisions should be made, well wide of the disease, and meeting above and below. The first incision having exposed the cord above, this is defined, and the scrotal tunics are quickly shelled off with the right hand, while the testis is still further protruded with the left.† The spermatic cord is now isolated as high as may be needful, the inguinal canal being carefully opened upon a director, if this is necessary to get above the disease. An aneurism needle, threaded with a double ligature of carbolised silk or stout chromic gut, is passed through the cord, the loop of the ligature cut, the needle withdrawn, and, the cord having been tied

FIG. 293.*



in two halves, the ends of one ligature are cut short, while those of the other are tied round the whole cord to ensure that no vessel escapes. The ends of this also are then cut short. The ligatures being thus embedded in the cord substance, there is no risk of their slipping, and if they be tied as tightly as possible (by looping the ligatures round two pairs of scissors or forceps), there is no danger of after suffering or tetanus. Other methods consist in securing the vessels alone, singly, by torsion, or by chromic gut, or by fixing the cord in the upper angle of the wound with a clamp. The mode of ligature above given is much more speedy and also, I am certain, perfectly efficient. Securing each vessel is tedious, as it is needful to make sure of every one, even when they are not enlarged, a condition not infrequent in growths. If any of the arteries are left unsecured, dangerous bleeding, when the cord retracts upwards, calling for laying open of the canal, with the risk of cellulitis, is very probable.

* In malignant disease the incision should be carried up much higher into the groin, and the cord tied close to the internal ring. To prevent a hernia the layer should be sutured according to the directions given at p. 804.

† There is often an adhesion below, between the testis and the fundus of the scrotum (Fig. 293). This represents, according to some, the remains of the mesorchium.

The cord, having been secured, is severed at least an inch above the disease, and the mass removed. The wound is then examined in the case of a soft, rapid growth, and where a tubercular testis has threatened to fungate, any suspicious skin must be clipped away, and a sharp spoon freely used.

A few scrotal vessels, notably one in the septum, may require securing. The wound is then closed with carbolised silk and horsehair, pains being taken to meet the tendency of the scrotal edges to invert.

Every precaution should be taken during and after the operation (including irrigation with hydr. perch., 1 in 4000) to promote rapid healing, especially in hospital practice. Patients who have to submit to castration are often reduced in health, and are thus liable to erysipelas, and in cases which become septic a low form of peritonitis is very likely to follow, especially if the canal has been opened up; moreover, septic thrombosis may easily follow on a wound made in a region so abounding in lymphatics and loose cellular tissue.

CHAPTER XIV.

OPERATIONS ON THE ANUS AND RECTUM.

FISTULA. — HÆMORRHOIDS. — FISSURE. — PROLAPSUS.
— EXCISION OF THE RECTUM. — IMPERFORATE
ANUS. — ATRESIA ANI. — IMPERFECTLY DEVE-
LOPED RECTUM.

FISTULA.

Varieties.—As these have a very practical bearing upon the operation they must be alluded to here.

i. *Complete*. ii. *Blind External*.—Here an external opening only exists, though in a considerable number of cases the internal opening is overlooked. iii. *Blind Internal*.—An opening through the mucous membrane is here the only one.* This is the rarest, but an important variety, as, if overlooked, it is certain to be troublesome.

Situation of Openings.—Both of these are usually within an inch, more often $\frac{1}{2}$ inch, of the anus. The internal one may be detected as a slight depression or papilla by the finger, or by the speculum, or, in obscurer cases, by Mr. Lund's method (p. 685).

Horseshoe Fistulæ.—Here an external opening on either side communicates with a single internal one, often at the back. This is an uncommon but an important variety, for if it is found necessary to cut through the sphincter ani at both sides, some loss of power is very likely to ensue. This risk should be explained to the patient, and the shallower fistula should be scraped, while the deeper is freely incised. If it is necessary to cut the sphincter on both sides, the knife should be employed on two distinct occasions, time being given for the first to heal.†

Multiple Fistulæ.—This condition should always cause a suspicion of stricture, or extensive ulceration—*e.g.*, syphilitic, &c.

* A discoloured dot or patch of skin sometimes marks the place where an external opening may occur. Mr. Lund (*Hunt. Lect.*, p. 88) relates a case in which a very chronic and slowly advancing blind internal fistula had excited, by its extreme end, just enough inflammatory thickening of the skin as to imitate a keloid growth, for which it was at first mistaken.

† Mr. Cripps (*Dis. of Rectum and Anus*, p. 165) shows that if, in women, the sphincter is cut through anteriorly where it decussates with the sphincter vaginæ, incontinence of fæces is very likely to take place.

Fistula with Tuberculosis.—Where a fistula presents an external opening with undermined, livid edges, where the tubera ischii stand out prominently from emaciated nates, and where the hair of the part is long and curled, tuberculosis is always to be suspected, even if no history of cough or hæmoptysis is given.

Question of Operating on Phthisical Patients.—While each case must be decided by itself, the following remarks may be useful:

Where the phthisis is advanced, the cough incessant, the fistula multiple or branched, an operation is out of the question. On the other hand, where the physical signs are little marked, night sweats slight or absent, where the fistula interferes with the patient taking the all-essential exercise, where the power of repair is good, an operation is indicated.

In cases intermediate between the above each one must be decided upon its own merits.

Before operating, the surgeon should remember that repair is here often sluggish, the mental condition much depressed. He should do all he can to improve the general condition before and after the operation. And if this can be performed in sunny weather, or, better still, at the sea-side, so that the patient can soon have fresh air in the recumbent position, so much the better.

Operation.—For a few days before the operation the diet should be restricted, and the bowels emptied by aperients. The hour of the operation should be so arranged as to give time for the enema which should be given to come away. The patient being under an anæsthetic, and either on his side with the knees well flexed, or in lithotomy position, the surgeon introduces lightly a fine Brodie's probe. In the case of a complete fistula, the internal opening being hit off (p. 1073), the point of the probe is felt for by the finger and hooked out of the anus. If, after careful examination, the surgeon is satisfied that no internal opening exists, he makes one by finding the exact spot at which the coats of the bowel are most thinned, thrusting the point of the probe through here.

In the case of a blind internal fistula the internal opening must be found with a speculum, and the probe, curved, passed from this so as to project beneath the skin. In every case the whole length of the sinus between skin and bowel must be completely laid open. When this has been done, very careful examination is made for other sinuses by the introduction of the probe, and by pressure with the finger, which squeezes out any discharge, and feels for indurated tracks. Wherever these run, they must, if possible, be laid open. I have already (p. 1073) alluded to the question of dividing the sphincter in two places. If any sinus seems to run dangerously high, hæmorrhage may be avoided by dividing it with a small écraseur, or, more gradually, by the elastic ligature. Every attempt, however, should be made with the aid of a good light and forcible dilatation of the sphincter to lay open every sinus with bistoury or scissors, extra care being taken,

the higher the incision has to be carried, to arrest all bleeding with carbolised silk ligatures, or by leaving on Spencer Wells' forceps.

While the sinuses are being followed up, any old gristly tissue must be completely removed, all pyogenic or granulation tissue entirely scraped out, and every ill-nourished flap and tag of undermined skin cut away.

If any troublesome piles co-exist they should be tied and cut away at the same time (p. 1076) or crushed (p. 1078).

As a dressing I prefer a little twisted salicylic wool dusted with iodoform, as I find this adapts itself more easily to the different wounds. Less and less should be re-applied, daily, as granulations become established. Daily plugging with strips of lint out of carbolic oil only makes the wounds irritable and œdematous. After the first week little more is needed than daily cleansing of the wound with a camel's-hair brush, or a dossil of cotton wool on a Playfair's probe. If the edges of the wound close too soon they should be separated with a probe from time to time, or any redundancy may be painted with cocaine and snipped away.*

Finally, no operation better exemplifies the truth of Mr. Curling's saying, that the surgeon should be here his own dresser.

Immediate Union of Fistulæ.—Mr. Reeves recommended this treatment some years ago (*Brit. Med. Journ.*, vol. i. 1887, p. 917). It certainly has the advantage of often shortening the treatment greatly,† and preventing loss of sphincter power, but at the risk of two dangers: (1) Sepsis. (2) The part within the bowel is sometimes difficult to suture satisfactorily and may persist as a sinus later. The method is suited to simple cases which do not extend far into the bowel. **Operation.**—The sinus having been well dilated, the fistula is laid open, thoroughly scraped out, any skin or mucous membrane which is unhealthy or which will get between the edges of the wound must be snipped away, the bleeding stopped, the wound well irrigated with lot. hydr. perch. (1 in 4000) and well dried out. It is then united in its whole extent by sutures of salmon-gut or sterilised silk. These are left in for a week or ten days. During this time the bowels which have been previously (daily) thoroughly emptied, and cleansed with naphthol must not act. A glycerine or oil enema must prevent any passage of scybala and straining at the time of the first relief.

HÆMORRHOIDS.

Indications.

1. Continuance of hæmorrhage or discharge, and persistent liability to descent of piles in spite of judicious treatment.

* Another excellent dressing, later on, is tr. benz. co. or dilute nitric acid lotion, 10 minims to 1 oz. The latter needs changing every four hours.

† It is right to add that the tediousness of the after-treatment is often due to the patient refusing to lie up, or to inefficient attention on the part of the surgeon himself.

2. Absence of albuminuria, diabetes, and hepatic (probably, cardiac) disease.

3. Amenability on the part of the patient.*

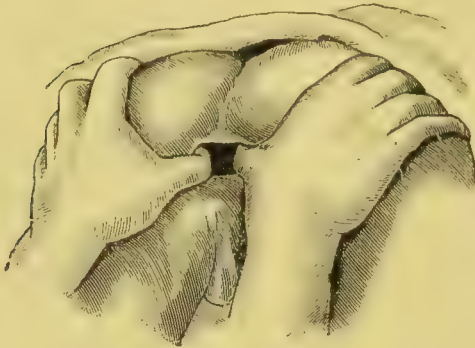
Operations.

Ligature. — Cautery. — Crushing. — Acid. — Whitehead's Operation.

i. **Ligature.**—I have placed this first, from a strong belief that, if properly used, it is, on the whole, the best method and the one most generally applicable. Here, as elsewhere, that surgeon will have the best results who has thoroughly familiarised himself with the details of one operation. The following appears to me to be a fair way of putting the merits of ligature and the other operations:

1. In my opinion the ligature is more generally suited to all cases. Again, it can be more easily applied to piles high up than

FIG. 294.



Forceible dilatation of the sphincters.
(Esmarch and Kowalzig.)

can the cautery. 2. No special instruments are needed. 3. A ligature applied is done once for all; the cautery may have to be reapplied more than once if bleeding follows when the clamp is unscrewed. 4. The risk of bleeding is less, and hence this method is especially advantageous in anæmic patients, and in those for whom it might be difficult to immediately obtain surgical aid (Allingham). 5. The ligature is free from the objec-

tions to the cautery in private practice—viz., the smell, and, unless a Paquelin's cautery is at hand, the cumbersome apparatus otherwise rarely used.

Operation.—The preparatory treatment is that given at p. 1074. The patient being on his left side, or in the lithotomy position, the anus should always be dilated. This may be done by introducing, and then separating laterally, the two thumbs (Fig. 294), the pressure being steadily maintained so as not to rupture the mucous membrane; after a few minutes a sensation of yielding rather than of tearing is perceived. Another method is to intro-

* In Mr. Cripps' words (*loc. supra cit.*, p. 99): "The smallness of the risk should not lull the surgeon into a sense of absolute security, and he should spare no effort in ascertaining the general constitutional condition of his patients. . . . The amount of risk, slight as it is, should be clearly laid before the patient or his friends. If a man is to have some grave operation performed, such as the removal of a cancer or the amputation of a limb, both he and his friends are well aware of the risk involved, and are accordingly prepared. It is therefore in the smaller operations, regarded by the surgeon and public as free from danger, that a fatality, when it does occur, becomes so tragic from being unexpected."

duce a large bi- or multi-valve vaginal speculum, and to withdraw this expanded.* When the sphincters are thoroughly dilated the piles which lie lowest according to the patient's position† are drawn down with a vulsellum or tenaculum-forceps, and the surgeon with blunt-pointed scissors, curved on the flat, cuts a groove around the lower two-thirds of the pile, which is thus separated for this distance from the sub-mucous and muscular coats. In the lower piles this groove should commence in the sulcus, which marks the junction of skin and mucous membrane close to the anus. The object of this groove is twofold. It forms a bed in which the ligature can be sunk tightly, and, above all, it leaves a very small pedicle of tissues to be strangled. The groove, moreover, can be cut without risk of hæmorrhage, as, however large the pile, its vessels enter it from above, running into its upper part just beneath the mucous membrane. The surgeon then ties round each pile, which is now still further dragged down, a ligature of well carbolised silk, the strength of which he has previously tested. Sinking this into the groove, he tightens it up so as to embed his ligatures firmly, without cutting through the pedicle. About two-thirds of the pile are then cut away, enough being always left to ensure a safe hold for the ligature. In Allingham's *Diseases of the Rectum*, p. 146, the following most important practical point is insisted on. When the piles are separated from the bowel preparatory to applying the ligature, it is essential that the base to be ligatured should be as narrow as is consistent with safe securing of its blood-supply. For if many piles have to be tied, and their bases are left large and broad, when tied up they draw the mucous membrane together, and cause great narrowing of the rectum. In such a case it is almost impossible to introduce the finger, without force, beyond the parts tied. In other words, islets of untied mucous membrane, as wide as possible, should always be left between the tied piles. This will secure less pain, easier action of the bowels, and less risk of contraction. After every internal pile has been carefully treated in this way, the external ones are partly clipped away, care being taken not to encroach upon the junction of skin and mucous membrane, and not to remove subcutaneous tissue for fear of subsequent contraction. If any bleeding points still persist, they should now be tied. The ligatures are all cut short, and lastly the stumps of the piles, after thorough irrigation with lot. hydr. perch. (1-4000) and rubbing in of iodoform powder, are returned. Strips of iodoform gauze wrung out of carbolic-acid lotion are then

* Eversion of the rectal mucous membrane by a finger in the vagina will often be most helpful in bringing piles within reach.

† This prevents the other hæmorrhoids being obscured with blood. Mr. Allingham advises that the smallest piles should be taken first, as there is a danger of these being overlooked and thus leading to a recurrence of the disorder.

applied, and firm pressure made with a T-bandage and the aid of a pad of salicylic wool, carbolised tow, or "tarred cotton."

ii. **Clamp and Caution.**—This method has been perfected by Mr. H. Smith.* The preparatory treatment and position of the patient are those already given. The piles having been sufficiently protruded, and the anus forcibly dilated, they are drawn well down, one by one; with vulsellum forceps, and enclosed within the blades of the clamp, which is screwed tightly up. With scissors curved on the flat the pile is then so cut away as to leave a sufficient stump. This is then carefully and thoroughly seared down with a Paquelin's cautery, carefully kept at a dull red heat. If the iron sticks at any moment, owing to its cooling down, it should not be pulled away, but loosened by heating it a little. The clamp-screw is then slightly relaxed, and if any bleeding takes place it is at once tightened up, and the cautery reapplied. Every care must be taken to burn down the stump thoroughly at the first attempt, for if this fail, and oozing take place, it is not easy to stop the bleeding from the tendency of the stump to slip through the slackened clamp. Each pile having been successively dealt with in this way, the stumps are smeared with iodoform ointment and pushed well up with a finger coated with the same.

This method is thought by some to secure more rapid healing with less pain than the ligature. This, however true of the old methods, does not hold good when the piles are freely detached and the ligature tied with the precautions already given. The clamp is less easily manipulated in the rectum, it is a special instrument not always at hand, and the smell entailed by the cautery is most unpleasing. The surgeon who uses it must be extremely careful to keep his seared surfaces as small as possible, and by no means to entrench upon the skin. It is well known how slowly, how painfully, and with what a tendency to contraction burns heal.

iii. **Crushing.**—This method was prominently brought forward by Mr. Pollock (*Lancet*, vol. ii. 1880, p. 1, *et passim*) as less painful than the ligature, and as leaving a mere thin and superficial fringe of dead tissue, instead of the slough of the clamp and cautery. The anus being fully dilated, each pile is drawn down with a vulsellum, and firmly crushed for a period varying from one to three minutes. The projecting part of the pile should then be cut away. The best instrument is Mr. H. W. Allingham's "screw-crusher." This has enormous power, and possesses the advantage that it may be introduced into the bowel. Skin should not be crushed, an incision being always made, when needful, at the junction of skin and mucous membrane. The upper part of the instrument should rest within the rectum, so as not to drag on the mucous membrane. Mr. Allingham (*Dis. of Rectum*, p. 133) has found that pain after this method is rather less than after the ligature, and that recovery is somewhat more rapid. (Edema of the parts outside may be very marked; "contraction so as to require dilatation by bougie or finger occurred about as frequently as after any other

* Mr. H. Smith (*Syst. of Surg.*, vol. ii. p. 840) has almost entirely discarded the use of scissors, removing the clamped piles with heated cauterics instead. Three of these are figured.

method of operation upon piles, but far less than after the cure by the actual cautery." Hæmorrhage is extremely rare after careful use of the screw-crusher. If it occurs, it is best arrested by leaving on Spencer Wells' forceps. Mr. Allingham gives the following advice as to suitable and unsuitable cases: "It may be used when the piles are small and not numerous, say three in number. It may be applied to remove a pile or two when operating for fistula. Partial prolapse of the mucous membrane falls within the same category. I should not advise its use in cases of very large vascular piles, in which, from excessive hæmorrhage, the blood is poor and non-coagulable. In cases of anæmia as a result of hæmorrhage, in which recurrent or secondary hæmorrhage would probably cost the patient his life, this method is decidedly dangerous. It should not be used to remove inflamed piles. It is not wise to crush piles when the patient is at a distance from skilled assistance, for fear of hæmorrhage coming on."

iv. **Acid.**—This method, formerly much over-rated, should be reserved for that rare variety of pile, sessile, perineal, usually, in position, and with a florid, granular surface. Vaseline having been applied around, the surface of the pile is dried, and carefully rubbed over with fresh, strong nitric acid, or acid mercury nitrate, this being thoroughly applied with a glass rod or pointed bit of wood. The acid should be rubbed in and in, the pile being kept dry and the acid not allowed to run. Every atom of the florid surface must be converted into a brownish, shaggy slough.

Whitehead's* Operation of Excision of the whole "Pile-bearing" Area.—This extensive operation is intended to bring about a radical cure, its object being not only to remove any existing piles, but also all the mucous membrane in the lowest part of the rectum, which is the seat of piles, owing to the tendency of its veins to become dilated. Though Mr. Whitehead has performed this operation in three hundred cases without a fatal result or any drawback, I cannot but consider it needlessly extensive and severe, especially in patients of middle life, and in a part which cannot be kept sweet, even with the aid of iodoform. The operation by ligature, or by clamp and cautery, carefully performed, gives most excellent results, and in answer to Mr. Whitehead's argument, that as long as this diseased area is left to reproduce piles over and over again, no permanent cure can be expected, I may say that I have always found that, after one of the above operations has been properly carried out, the patient can easily prevent any recurrence by attention to common-sense details in daily life. Finally, I know of one case, in a young, healthy patient, fatal from blood-poisoning.

The following criticism (Allingham, *Dis. of Rectum*, p. 139) appears to me soundly based: "Mr. Whitehead terms his operation simple. Simple it may be, but difficult to perform, for with the anus rugose and elastic as it is, even after dilatation of the sphincters, it is not at all easy to separate the mucous membrane from the skin. The time required for the operation is an objection; this process takes on an average at least thirty minutes, where a skilled surgeon can operate with the ligature in less than five minutes. The hæmorrhage by this method far exceeds the amount lost when the ligature is used, and this is of great importance in those patients who have already lost much blood from their piles. . . . Two or three days after the operation the parts not unfrequently become swollen, and the mucous membrane then tears through the ligatures and retracts away from the skin. This leaves a large granulating surface which may occupy the entire circumference of the bowel, and cause troublesome contraction.

Operation.—The sphincters having been thoroughly dilated, and the hæmorrhoidal area of mucous membrane made to prolapse, the line of junction of skin and

* *Brit. Med. Journ.*, February 26, 1887.

mucous membrane* is looked for, and the latter divided along it all round the anus with blunt-pointed scissors. The cut mucous membrane is then dissected up, with forceps and scissors, from off the external and (in part) the internal sphincter, till the whole of the pile-producing area of mucous membrane can be pulled down and drawn outside the anus. It is then cut away, bit by bit,† transversely at its still attached upper border, each portion when divided being at once attached to the cut skin with carbolised silk sutures. In this way the diseased area is removed as a complete ring of mucous membrane. Each bleeding-point is secured by torsion or forcepressure. Iodoform is dusted over the wound. The sutures are allowed to come away of themselves.

Causes of Failure and Trouble after Operations for Hæmorrhoids :

1. Hæmorrhage.—This will be extremely rare if the ligature method be carefully employed. The conditions under which this complication may occur are cases of long-standing piles or prolapsus in weakly subjects, cases where the tissues are very friable, where the patient insists on getting out of bed to pass water, or where he strains very much at the first action of the bowels. If the surgeon be called upon to meet it, the best means is to apply Spencer Wells' forceps, and to leave these *in situ*; in a severer case, or where the above are not available, Mr. Allingham's plan of plugging should be used (*Dis. of the Rectum*, p. 67). Through a conical sponge a silk ligature is threaded from apex to base. The sponge, well dusted with iodoform and steel sulphate, is pushed 4 or 5 inches into the bowel, and the whole of the space below it is plugged with aseptic gauze. The sponge is now pulled *down* by the two ends of the ligature while the gauze is pushed *up*. The plug should be left in as long as possible, the patient being kept under the influence of laudanum. It is well to pass a large catheter through the sponge before this is inserted, to allow of escape of flatus. 2. Tedious ulceration.—This is usually due to the patients getting up too soon. They should remain in bed a week or ten days, and then be content to pass another ten or fourteen days upon the sofa. 3. Septic troubles. 4. Contraction.—This is usually stated to be only likely to occur when, in cutting away piles, especially external ones, the junction of skin and mucous membrane is trenched upon. But the fact is that where many piles have had to be removed, where islands of mucous membrane (p. 1077) have not been left between them, the ulcerated surfaces thus tending to coalesce, contraction of the surface as it cicatrises is very likely indeed to lead to some narrowing of the lumen of the gut. This must always be prevented by the early passage of the finger of the surgeon in charge, this being repeated daily if any tendency to contraction is found. Where a stricture, generally about $1\frac{1}{2}$ inch from the anus, has been allowed to form, the patient's condition is a most vexatious one, though it will always

* The "white line" of Mr. Hilton (*Rest and Pain*, p. 289, figs. 51 and 52).

† So as to diminish the hæmorrhage, which would otherwise be free at this stage.

yield to the use of bougies, aided, if need be, by nicking of the contraction. 5. Abscess. 6. Fistula. 7. Bubo. 8. Pelvic suppuration. These four are given by Mr. Allingham (*loc. supra cit.*, p. 163) as sequelæ in unhealthy patients, especially if the healing has been accompanied by prolonged suppuration. The antiseptics of the present day should prevent this.

FISSURE.*—ULCER.

The operative treatment of these is so simple and so eminently successful, that it should be resorted to early.

Operation by Incision.—The preparatory treatment and the position of the patient are the same as those already given. The division of the ulcer may be performed in one or two ways—*(a)* From without; *(b)* from within the rectum.

(a) From without.—Here the ulcer, being fully exposed with a speculum—and the one which bears Mr. Hilton's name, with a movable valve, will be found the best—a small sharp-pointed bistoury is inserted a little beneath the base of the ulcer, and its point made to protrude in the bowel above it; the parts are then divided from without inwards through the centre of the ulcer.

(b) From within.—Here, the ulcer being also exposed, either by stretching the parts with two fingers or with a speculum, a straight blunt-pointed bistoury is drawn across the whole of the sore, through its centre.† Mr. Curling (*Dis. of the Rectum*, p. 12) has drawn attention to an important point here, and that is, that the fibres of the muscle at the extremity of the ulcer near the verge of the anus should be divided rather more freely than those above, so as to avoid any ridge or shelf on which the fæces would lodge.

There is usually no hæmorrhage to speak of, and the whole operation is so simple that it may be performed after an injection of cocaine, or with nitrous oxide gas, unless anything else—*c.g.*, attention to piles—is required. I prefer, however, to operate with ether or the A. C. E. mixture.

Of the two methods, I generally make use of the first, following Mr. Hilton. I consider it the more certain, and have never known of anything like incontinence in the nine cases in which I have used it. The second is rather the slighter operation, and also gives good results.

The position of these usually club-shaped ulcers is posterior. If one is met with anteriorly in a woman, it would be wiser to try the application of acids, or the actual cautery. See foot-note, p. 1073.

* This condition, often called a fissure, nearly always amounts to an ulcer when it is carefully examined and the parts unfolded.

† Mr. Cripps (*Dis. of Rectum and Anus*, p. 176) says, "so as to divide about a third of the fibres of the external sphincter."

The surgeon must be careful, when examining into the amount of repair a week or two later, not to do any damage if a speculum is employed.

Operation by Dilatation of the Sphincter.—This is not only rough but uncertain, and should not be employed.

PROLAPSUS.

Indications.—Failure of previous treatment. Large size and long duration of the prolapsus. Altered condition of the mucous membrane—viz., thickening or ulcers, the latter giving rise to hæmorrhage. Incontinence of fæces, especially when fluid, or of flatus.

Operations.

Acid.—Cautery.—Excision.

1. **Acid.**—Of these I prefer the acid nitrate of mercury. This method is especially applicable to the obstinate cases of prolapsus in children, where the bowel is constantly down. Though, if the application is made properly, only a sensation of burning is complained of, an anæsthetic should always be given. The patient being in the lithotomy position, or on one side, the prolapsus is carefully dried of all mucus, and the surgeon rubs in the acid with the aid of a glass rod or pointed pieces of wood, the adjacent skin being protected with vaseline.

Care must be taken not to rub in the acid too long or too vigorously, for if the inflammatory process set up affects deeply the sub-mucous tissue, a most troublesome stricture may readily result.

It is well to warn the patients that a second application may be required in severe cases.

The after-treatment is that given below.

2. **Cautery.**—In severer cases, or where the acid has failed, the following will be found efficient. The position of the patient is as for pile operations, but it is best to apply the cautery to the bowel *in situ*, though this may be used when the bowel is prolapsed.

Thus, the patient being in lithotomy position, and a duckbill-speculum introduced and held in contact with the anterior wall of the rectum, the blade of a thermo-cautery is drawn edgeways along the lower three or four inches of the opposite surface of the gut. The speculum being shifted, the anterior and lateral aspects are similarly treated in severe cases.

Care must be taken not to go *through* the mucous membrane, or septic mischief and sloughing may be set up in the cellular tissue beneath.

3. **Excision.**—In severe cases, in adults, when other methods have failed, this method should be resorted to, but even with the improvements of the present day there must always be a difficulty in keeping wounds here aseptic.

The patient being in lithotomy position, the prolapsus reduced, and the parts exposed by a duckbill-speculum, two or more elliptical pieces of mucous membrane are removed by pinching them up with vulsellum-forceps and cutting them away with a very sharp scalpel or scissors. Any bleeding vessels are then tied with chromic gut, and the edges of the wound united by horsehair or fishing-gut sutures, a horsehair drain being inserted first. Iodoform is then carefully dusted on, and the parts smeared with an ointment of the same.

The insertion of sutures has the advantage of preventing hæmorrhage, and hastening the cure. The disadvantage is that an anæsthetic will probably be required for their removal. Especial care will be needed now not to break down

the union with the speculum. The wounds must be irrigated frequently with a solution of hydr. perch. (1 in 4000), and a small Higginson's syringe.

After-treatment.—After any operation for prolapsus, the patient must rest for three weeks on the sofa to allow of firm consolidation and cicatrization taking place. Light diet alone should be allowed at first, and the bowels should, at first, be allowed to act only every three days, and, if possible, while the patient is on his side.

EXCISION OF THE RECTUM.

Partial excision would be usually a more correct term in the great majority of cases, but as by the sacral route, first brought before the notice of the profession by Kraske, the rectum has been removed up to the sigmoid flexure, I retain this heading. Under it the following operations will be considered: (i) **Excision from the perinæum.** (ii) **Excision through the vertebræ, by removal of coccyx and part of sacrum.** (iii) **Combination of the perinæal and vertebral routes.** (iv) **Excision by the vagina.** (v) **Excision by abdominal section.**

(i) **Excision from the perinæum.**

Indications. Suitable cases. 1. Malignant disease of anus—*e.g.*, papillomata or a neglected fistula, or condylomata becoming epitheliomatous. 2. Malignant disease of the rectum.* Of the points which have to be now considered, the extent of the disease, especially in an upward direction, is the most important. A growth which is limited to the lower $2\frac{1}{2}$ or 3 inches of the bowel, especially if placed upon the sacral aspect, or if not creeping far forwards upon the sides, may always, *cæteris paribus*, be attacked by experienced hands.

I am, of course, aware that larger portions of the bowel have been removed successfully by the perinæal route, and I recognise the objections to making any rule in such cases as these, where each must be taken separately. But I am of opinion that the above limit is a wise one in the majority of cases for this reason. All thoughtful surgeons will allow that it is idle to allow less than a full inch of margin between the growth and the site of division of the bowel. This sounds simple, but is not easily carried out owing to the hæmorrhage, dread of opening the peritonæum and the tension exerted on the bowel; thus the incision is often made dangerously near the growth at one or more places. On the other hand, an incision through the bowel, $3\frac{1}{2}$ inches from the anus, brings the surgeon very near to the recto-vaginal or recto-vesical reflexion of the peritonæum.† As Mr. Cripps

* Much more rarely non-malignant stricture and ulceration may be treated in this way instead of by dilatation, but only in cases where extensive ulceration exists with multiple points of stenosis, and the use of the bougie is found to be ineffectual.

† On this subject Mr. Allingham (*Intern. Encycl. of Surg.*, vol. vi. p. 122) writes: "It is well to remember in the female how near to the perinæum the peritonæal membrane descends, it being much more commonly at a shorter distance than 3 inches than at a distance in excess of that measurement. In the male, however, $3\frac{1}{2}$ to 4 inches from the anus is the common site for the reflection of the peritonæal membrane." Mr. Allingham states that he has met with the peritonæum within 2 inches of the anus in a woman, and removed 5 inches of the intestine in a man without ever having seen the membrane. In estimating the possibility of safely getting above the disease, and the proximity of the peritonæum, the tendency of the growth to draw down this membrane will not be lost sight of.

points out (*Dis. of the Rectum and Anus*, p. 422) involvement of the peritoneum by the disease entails two risks: (1) that the peritoneal sac will of necessity be opened at the operation; (2) that the disease having once implicated this membrane is nearly sure to have spread in the course of the lymph-paths beyond the reach of complete removal. Mr. Cripps, one of the chief authorities on removal of the rectum by the perineum, states that, in his opinion, "the disease must be within 4 inches of the anus, and in women must not have extended on the anterior wall further than 3 inches." *

In addition to the extent of the growth, the following must be taken into consideration: Its mobility. This is most important and difficult to estimate. The administration of ether or A. C. E. may help here as well as in deciding the extent of the disease. The parts where it is most difficult and important to estimate the mobility are the neighbourhood of the prostate, urethra, and the neck of the uterus.† The recto-vaginal septum if involved in its lower part may be cut away, but the patient will be liable to find faeces getting into the vagina, especially when the bowels are loose. The condition of the glands, sacral, iliac, and inguinal, will, of course, be examined, and the possibility of deposits in the liver remembered.

Glandular infiltration is said by several to occur late in rectal carcinoma. This, at first sight a point which may favour operation, is counterbalanced by the well-known fact that rectal carcinoma is frequently insidious, and that thus, by the time it has pronounced its existence, it is already in an advanced stage.

Finally, the age of the patient, this being not judged of by years alone, the condition of the kidneys and other viscera, whether the general condition and reparative powers are sufficiently good to meet the calls of what may be a very severe operation, must all be taken into careful consideration.

Much information bearing on the value of excision of the rectum will come out if we institute a **comparison between Excision of the Rectum and Colotomy**.—The chief points calling for attention are—(i) The mortality of the operation. (ii) The duration of life after it. (iii) The amount of comfort given by it.

(i) *The Mortality of the Operation*.—In instituting a comparison on this head between colotomy and excision of the rectum, one important point must always be remembered—*i.e.*, that the latter operation is never performed under those unfavourable conditions of obstruction which, owing to the operation being often deferred till too late, render the mortality of colotomy such a high one. Turning to the mortality of excision by itself, without comparison with any other operation, we find that Mr. Butlin (*Oper. Surg. Malign. Dis.*, p. 241) who has collected one hundred cases from various sources, gives a mortality of 35. This death-rate of one-third he regards as far too high, and as capable of reduction by one-half, or even more, by attention to antiseptic details, and also by abandoning the practice of drawing down and suturing the cut bowel, a practice which has been largely followed at Vienna, and which, by causing retro-peritoneal suppuration, has greatly increased the mortality.

Mr. Ball has collected 175 cases which he considers reliable with a death-rate of 16·5 per cent. A fallacy here has been overlooked. In this, as in every

* If the disease is adherent to the upper portion of the vagina, Douglas's pouch is nearly sure to be drawn towards the disease, which cannot be removed without opening the peritonæum.

† Mr. Cripps thinks that though the bowel in contact with the prostate may be diseased, it is a long while before the prostate itself becomes infected: in women, on the contrary, when the disease is on the anterior part of the bowel, the vagina and uterus quickly become implicated.

other comparatively novel and important operation, a very large number of unsuccessful cases will remain unpublished, whilst nearly every successful case is reported at once. The real death-rate, therefore, when the facility with which shock, hæmorrhage, cellulitis, peritonitis may occur in a part which cannot be kept absolutely aseptic, and in patients no longer young and the subjects of rectal cancer, is fairly estimated, lies probably between the two figures given above. Nor when we consider how limited man's capacity for bearing grave operations remains (p. 778), however much we have advanced in surgery, is it at all probable that the death-rate will fall much below 20 per cent., if all cases operated on are honestly reported? When we consider the mortality of inguinal colotomy for rectal cancer, excluding the cases where colotomy is performed under the most unfavourable circumstances of obstruction, in other words "the too late cases," the mortality will be distinctly less, varying from under 5 to under 10, accordingly as the operation is performed by operators of especial experience or otherwise. Here, too, the value of statistics is greatly impaired by the tendency to publish only successes. But there can be no doubt whatever that colotomy in cases uncomplicated by obstruction is most distinctly a safer operation than excision of the rectum from the perinæum, and, *a fortiori*, than the severer methods.*

(ii) *Duration of Life*.—With regard to this point, I think a larger number of cases will show that if the surgeon decides to advise, and the patient is willing to run the risk of, the more serious operation, the prolongation of life will be greater here than after colotomy, if the cases are wisely selected. I think that the above is borne out by the results of the statistics which we have. It is rare for patients after colotomy for carcinoma to survive more than one year and a half. Making due allowance for the advanced date at which cases of rectal cancer too often come under treatment, for the fact that excision will usually be performed in selected cases, and that thus colotomy will be reserved for those less favourable, I think the published cases of excision show a greater prolongation of life.

Volkman (*Sammlung Klin. Vorträge*, May 13, 1878) claimed 3 complete cures and several cases of very late recurrence—viz., one after 6 years, one after 5, and one after 3. One case died of carcinoma of the liver, 8 years after operation without local recurrence, and one case remained well 11 years after the removal of a large mass reaching high up: in this case recurrence occurred twice in the scar, and was removed. Czerny's experience is also very good. Two of his cases had survived the operation over 4 years, one 3 years and 4 months; three others were well after intervals of at least 2 years (Henck, *Arch. f. Klin. Chir.*, Bd. xxix. Hft. 3). Mr. Ball (*Dis. of the Rectum and Anus*, 2nd ed. p. 364) has had one patient alive and well 9 years and another 6 years after operation. Mr. Cripps (*loc. supra cit.*) has had one case free from recurrence 12 years, two 6 years, one 5 years, two 4 years, one 3 years after operation.

(iii) *Amount of Comfort Afforded*.—After this operation, as after excision of the larynx, a distinction must be drawn between mere survival and what deserves the name of recovery. The amount of comfort enjoyed by the patient will depend on: (1) The amount of contraction that takes place. (2) How far he

* Iversen, of Copenhagen (*International Congress of Medicine*, Berlin, 1890, Jan. 24, 1891), examining 247 cases of excision of the rectum, came to the conclusion (1) that removal of the rectum, while a most reasonable method and, in favourable cases, affording a radical cure, was a very dangerous operation. Of 19 cases of Kraske's operation 8 died. (2) The greater number of cases come too late for the operation and must, as before, be treated by colotomy. König's recent mortality has only been 10 per cent., and Czerny has operated in 18 cases with 4 deaths.

has control over his motions. The patient should always be warned about these sequelæ. If he does not keep under observation, and contraction follows, I consider his case will compare most unfavourable with that after a well performed colotomy, and may even be as bad as that of a patient with advanced rectal cancer. (1) Where the whole circumference of the bowel has been removed, a matter referred to below (p. 1090), it is obvious that there must be a great risk of contraction in the scar tissue which replaces the mucous membrane. This contraction forms a most serious difficulty in the after-treatment, and is liable to lead to most unsatisfactory results. The more the connective tissue around the bowel is interfered with, the more profuse the suppuration and the longer the healing, the more marked will the contraction be. Colotomy has been required for it, as occurred in a case under my care, where excision of the rectum had been performed elsewhere. The above risk may be obviated, no doubt, by drawing down the bowel and suturing it to the skin; but this step (p. 1089) is not often

FIG. 295.



(Allingham.)

feasible, especially in men, and if sutures are inserted they cut through quickly. It is at all times dangerous on account of the risk of leaving septic discharge pent up with very dangerous surroundings (*vide infra*.) The severed end of the bowel is drawn considerably downwards during the process of healing. This renders it easier for the patients to pass a bougie from time to time, the need of which must be firmly impressed upon them. Another means of securing the patency of the bowel is by wearing a vulcanite tube, as recommended by Mr. Allingham. These are 3 or 4 inches long, with one end conical, and with the other ending in a broadish flange to prevent its slipping into the bowel, and also to enable it to be stitched to a bandage which keeps it in place. Patients begin to wear it about a fortnight after the operation, and, save for taking it out when the bowels act, retain it constantly for some months, some having to wear it for the rest of their lives.

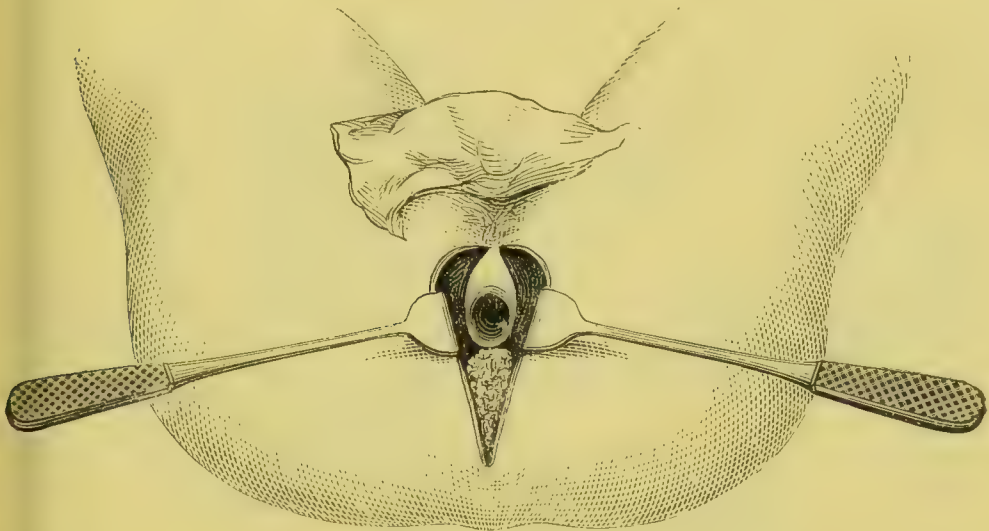
(2) As to the power of retaining fæces, incontinence is always present at first, but control is usually regained after a time, save where the motions are loose. Mr. Cripps (*loc. supra cit.*) states that incontinence was present in only seven out of thirty-six cases which he collected. It is possible that torsion after the advice of Guersun (*vide infra*), may be advisable as a preventive when the entire circumference of the bowel and the sphincters have been removed.

Operation of Excision of Rectum in its Entire Circumference.
 —The bowels having been well emptied by purgatives and enemata, the patient,

under the influence of ether or the A.C.E. mixture, is placed in lithotomy position, and the surgeon rapidly makes an oval incision into both* ischio-rectal fossæ, around the bowel, then prolonging this oval incision backwards so as to reach the coccyx (Fig.295). Mr. Allingham advises that the oval incision should be just above the external sphincter, or rather in the space between the external and internal sphincter, so as to leave the external sphincter (detached behind) attached to the skin. Better control over the motions is secured by this detail when it is safe to carry it out.

This backward prolongation is much needed in order to give additional room for meeting hæmorrhage,† and for providing drainage later on. The fingers, aided if needful by the knife or blunt dissector, separate the bowel at the sides and posteriorly as high as the levator ani; the hæmorrhage is usually not severe, and can be readily arrested by pressure-forceps, sponges pushed into the incision, and by operating as rapidly as is consistent with safety. The separation of the

FIG. 296.



(Allingham.)

bowel in front varies with the sex of the patient. In a male a full-sized metal sound having been passed into the bladder and kept well hooked up under the pubes,‡ the surgeon carefully dissects, partly with his finger and partly with scissors, between the bowel and urethra and prostate. These parts are naturally

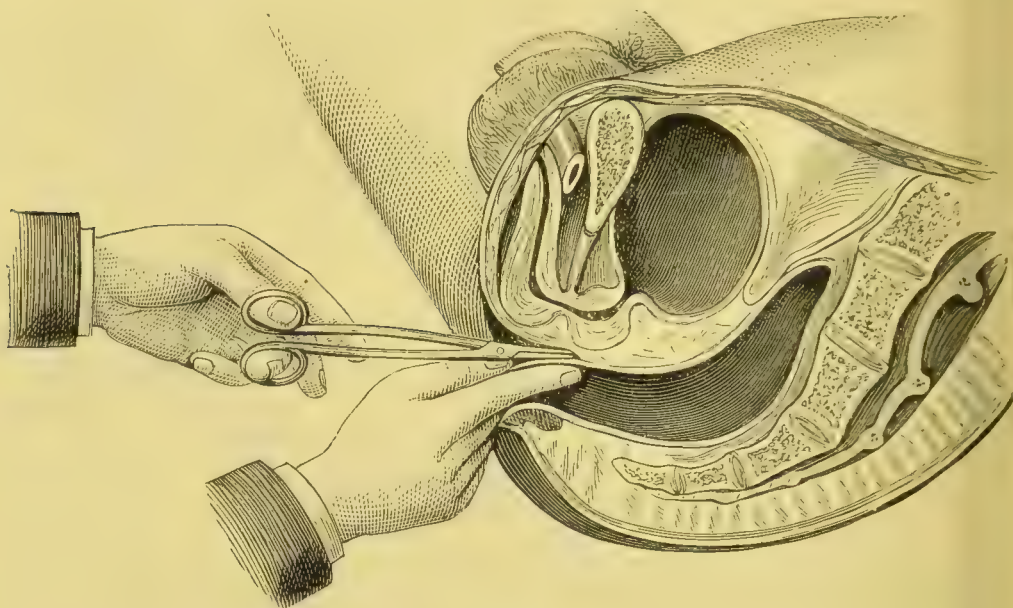
* If the disease is limited to one aspect of the bowel, the incision will be limited also.

† If this incision has to be carried as high up as 3 or 4 inches, the hæmorrhage will be free, as the superior hæmorrhoidal artery here divides into two terminal branches. A sufficient incision, well opened out with large retractors, will admit of easily dealing with this vessel. Another method is to begin by a free posterior incision, made by guiding a curved sharp bistoury well above the disease in the posterior wall, bringing out the point at the tip of the coccyx, and then cutting all the intervening tissues into the bowel. This exposes well the limits of the growth, but causes more bleeding. If the first method is made use of, the bowel must be laid open subsequently, to investigate the upper limits of the disease.

‡ Prof. Macleod advises that, if the disease is low down, it matters little whether the bladder is full or empty; if a higher portion has to be dealt with, as Dupuytren showed, the urine should be retained, so as to raise the recto-vesical pouch.

adherent, and this dissection must be carefully conducted, as any opening into the bladder or urethra will much increase the shock. If the left index be kept in the rectum and the thumb just outside it, they will serve to pull the bowel as it is freed away from the urinary tract, while the operator is at the same time kept informed how near to the bowel he is cutting (Fig. 297). In the case of a woman the surgeon's left index, or the finger of an assistant in the vagina, will give the best warning of his knife or scissors (the latter, long and blunt-pointed, are preferable) getting too near the vaginal mucous membrane.* If this be encroached upon, it must be removed without hesitation, in the hope that the cloaca thus formed will be much diminished by contraction, or that it may be closed subsequently. If the disease has extended up the recto-vaginal septum, the peritonæum must be looked out for, and the greatest care taken not to open this cavity at the upper part of the dissection. If this should occur, an aseptic sponge must be kept over the opening. The levator ani being carefully cut

FIG. 297.



(Allingham.)

through, the rectum, now separated everywhere save above, is dragged down by an assistant or by the operator with his left hand. While this tension is kept up, the surgeon with his finger, aided by scissors, frees the bowel sufficiently above the disease to admit of dividing it safely. Frequent examination of the interior of the bowel should be made at this stage to tell when the upper limit of the disease has been reached. The rectum should be divided at least an inch above this point. Before the bowel is cut away, the upper end should be secured with a vulsellum, for fear that it may retract and carry any still bleeding points out of reach.

When the bowel has been safely isolated above the disease, it must be divided with scissors. These are greatly to be preferred to the *écraseur*, as they give a much more cleanly cut surface, and one therefore less liable to slough, and they furthermore avoid the risk which is inseparable from the use of the *écraseur*—viz., its gradually encroaching, as it is tightened, more and more closely upon the diseased area.

* Subsequent sloughing here is not unlikely.

One objection to the division of the rectum with a Paquelin's cautery is, as remarked by Mr. Cripps, that the use of any form of cautery during the operation makes it exceedingly difficult to distinguish between the hard nodules of burnt tissue and portions of the disease which may be left behind.

The bowel having been removed, all bleeding points* are most carefully looked for, and the wound is thoroughly dusted over with iodoform, painted over with this antiseptic and ether,† and lightly plugged with strips of aseptic gauze.‡

If the peritonæum has been injured and the opening is too large for suturing, either a drainage-tube packed around with gauze (Bardenhauer), or a tampon of gauze, must be made use of.

Mr. Cripps considers that any attempt to bring down the cut edges of the rectum, and to stitch them *in situ* around the anus, is perfectly useless, as the sutures are certain to cut their way out, and harmful, as likely to prevent the escape of discharges. As this entails the very serious risk of septicæmia, the advantage which suturing the bowel would give, if it were safe, of preventing subsequent contraction (p. 1086) has been put aside.

On the other hand, Volkmann and Czerny (*loc. supra cit.*) have recommended the use of sutures so as to hasten healing and obviate the tendency to stricture. If they are employed, they must be passed as advised by Ball, not only through skin and bowel, but also deeply through the surrounding pelvic structures as well; drainage-tubes should also be inserted here and there between the sutures. Superficial sutures are then put in as well so as to further diminish the strain. If these precautions are taken, if no fæcal contamination of the wound has occurred, if antiseptic precautions have been taken throughout, and if the wound has been rendered thoroughly dry and bloodless, the employment of sutures deserves a further trial in appropriate cases.§

Resection of Rectum with Murphy's Button.||—As the inventor of this most ingenious instrument believes that its use will relieve the operation of "its most trying mechanical part—*i.e.*, the difficulty of drawing down and approximating the upper to the lower segment, suturing it there and still retaining the sphincter intact"—an account of the method will be given here. Dr. Murphy states that he has had three resections with three recoveries (*Chicago Clin. Rev.*, Feb. 1895). "(1) In order to do the operation without removing the coccyx or sacrum (Kraske), it is necessary to be able to reach the upper margin of the carcinoma with the index finger. (2) The sphincter should be dilated until it is completely paralysed; the cancer should be drawn down with forceps, and the rectum packed with gauze above. (3) A puckering string should be inserted in

* If the patient's strength fail towards the close of the operation, no time should be lost in tying the vessels, but each bleeding-point should be secured with Spencer Wells' forceps; these are removed in twenty-four or thirty-six hours.

† Throughout the operation the wound should be well syringed with a solution of mercury perchloride (1 in 4000). This should be used very hot, if there is troublesome oozing.

‡ If it is necessary to do this firmly, the plugs should be removed, by soaking, as soon as possible, in order to allow of escape of discharges.

§ Dr. Kelsey (*New York Med. Journ.*, vol. i. 1890, p. 478) while using sutures does not attempt, as do the German surgeons, to get union by first intention, but merely to bring the gut as low as possible, so as to shorten the interval which must be filled up with granulations. He also gives the useful hint to put provisional sutures into the deep posterior cut, to be tightened in a week or ten days, when the urgent need for free drainage has passed away.

|| This is described at p. 840.

and out through the wall of the rectum one half inch* below the carcinoma and left perfectly loose, so that the bowel may retain its entire calibre. (4) A circular incision is now made through the entire wall of the rectum, one quarter of an inch above the suture, and between it and the carcinoma. (5) The carcinoma and the rectum are then liberated from the surrounding connective tissue and the latter is drawn down as a cylinder into the lower segment of the rectum, and the separation continued until we are well up above the carcinoma. If it be a female patient we will find the cul-de-sac firmly adherent to rectum, usually at the seat of the cancer. It should be cut open, the portion adherent allowed to remain, and immediately sewn up with a fine catgut suture. The separation can extend up as far as necessary. One half inch above the carcinoma another puckering-string is inserted, and a circular incision is made a quarter of an inch below this, cutting out the carcinoma. The gauze packing is then removed. The male portion of the button, in which is threaded extremely heavy braided silk, double, drawn through the cylinder, is placed above, and the upper puckering-string tied round the cylinder and cut short. (7) Slide the female portion of the button over the string and press it up until it barely catches the end of the male cylinder, just sufficient to hold. (8) Make a small parallel incision in the lower segment of the rectum over the coccyx and one half inch below the first puckering-string inserted. Through this pass a strand of iodoform gauze for drainage outside of the button. This may be removed on the third or fourth day. (9) Draw the button well down, and tie the first puckering-string around the conjoined cylinder: cut the suture short and press the button together by making traction on the cord and pressing up from below. (10) Have the bowels loose before the operation, and keep them loose after the operation until the button loosens itself, or can be liberated by slight traction about the tenth day. Use heavy silk, both for puckering-string and for traction-cords, as it is very unpleasant to have it break. Do not press the button too close together before tying the second puckering-string. The traction-cords may be left in until the button is removed."

Question of Partial Removal.—If any of the mucous membrane, even a mere strip, can be *safely* left, the amount of subsequent contraction will be less: but here, as in all other operations for malignant disease, every consideration must give way to the chief object, that of extirpating the growth.

Partial operations should be reserved only for cases where the disease is very localised in amount, and admits of extirpation, together with a very wide margin of bowel. Where the disease implicates one-half of the bowel, even if apparently not disseminated in the mucous membrane, the whole circumference should be removed. Mr. Allingham thus condemns partial operations: "The partial removal of the circumference of the bowel is, in my opinion, most unsatisfactory. In all the cases in which I have removed only part of the wall there has been either a return of the disease in the rectum, or in the glands in the groin, or in some internal organ, mostly the liver."

If the surgeon decide on a partial operation, he must be prepared for some increased difficulty owing to the diminished room for working, and meeting the hæmorrhage. Perhaps only one semilunar incision around the anus will be required.

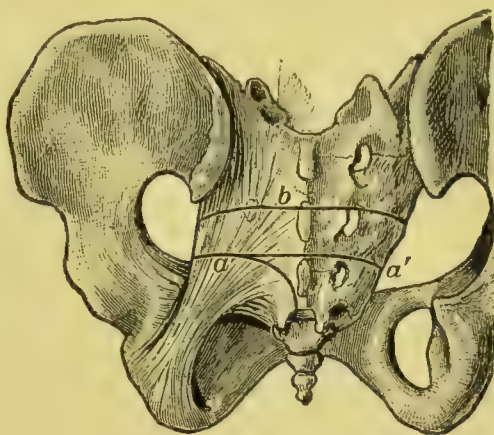
(ii) **Excision through the vertebræ, by removal of the coccyx, or coccyx and part of the sacrum.**—Kraske's operation and its modifications (Fig. 298).—Kraske, of Freiburg (*Arch. f. klin. Chir.* Bd. xxxiii. S. 563), introduced this route as best adapted for those cases which, in Volkmann's words, are situated too high for the perineal route and are too low and too fixed to admit of removal by abdominal section. It will be understood

* These and the other distances given appear to me inadequate and risky.

by all that this is an operation of great severity, and only justifiable when, as compared with colotomy, the risks on the one hand, and the advantage on the other, of attempting a radical cure, and, at all events, affording a greater prolongation of life (p. 1085), have been fairly put before the patient or the friends. Again, it is only a surgeon who has had large operating experience who should undertake, and only patients who have sufficient reparative power who should be submitted to, any of these operations of excision of the rectum, more particularly to this and the ones that follow. For at least four days before the operation the patient should be prepared by aperients and enemata and a wisely restricted fluid diet.* The parts having been previously shaved and cleansed, the latter process is repeated when the patient is passing under the anæsthetic, and the bowel cleansed as high up as possible by irrigation with lot. hydr. perch. (1 in 500), and with swabs of iodoform gauze on long forceps.

Dr. Kelsey insists upon this, as it may be of the greatest help to be able to introduce the finger into the bowel during the operation: "Exactly in proportion to the thoroughness of this disinfection, and to the care with which the wound is kept clean during every stage of the operation will be the mortality." A small tampon of iodoform gauze may be left in the rectum, but too large a mass obscures palpation of the diseased part from the incision. The patient is now turned on to his face,† or nearly so, and the cleaning of the parts completed. If the anæsthetic requires that the patient lie upon one side, the right is usually chosen. Whatever be the position, the pelvis should be elevated, so as to diminish hæmorrhage. An incision is then made in the middle line from the posterior edge of the anus to the centre of the sacrum,‡ the knife being carried down to the bone at once. A flap on the left side is then turned outwards, including a part of the glutæus maximus, and exposing the side of the sacrum and the sacro-sciatic ligaments. These last must be divided and detached from both sides of the coccyx and the left side of the sacrum, together

FIG. 298.



a. The incision, through the sacrum, of Kraske's (p. 1090). *a, a'.* That of Bardenheuer, who takes away the whole lower part of the bone as far as the third sacral foramina. *b.* Incision of v. Volkmann and Rose which passes through the bone at a higher level still. (Esmarch and Kowalzig.)

* Dr. C. B. Kelsey (*New York Med. Journ.*, vol. ii. 1895, p. 457) advises that a dose of morphine and bismuth should be given on the evening before, and repeated a few hours before the operation. The paper is an excellent one, full of practical hints, from which I have borrowed largely.

† This position is recommended by Mr. Godlee and Mr. Larkin (*Brit. Med. Journ.*, 1893, vol. ii. pp. 64, 153) as much more convenient throughout than that of resorting to the lithotomy one after removal of the bones.

‡ The upper limit of this incision must be according to the upper extent of the disease. In some cases removal of the coccyx will suffice (Verneuil and Kocher), in others, where the disease extends high up, the incision must be carried up to the 4th, 3rd, or even the 2nd sacral spine. When the incision is carried high up, it passes to the left and ends about two finger's breadth below the posterior and superior spine (Fig. 298).

with the coccygeus, part of the left pyriformis and, if the anal region is to be removed, the sphincter and levator ani. With a periosteal elevator passed under the sacrum the soft parts are now detached from the hollow of this bone, including the sacra media vessels and a venous plexus, thus avoiding troublesome bleeding. The surgeon must now decide how much bone requires removal. We will suppose a somewhat extensive case. The soft parts being vigorously retracted the surgeon cuts through the left side of the sacrum along a curved line (Fig. 298) commencing on the left edge, at the level of the third posterior sacral foramen, and running inwards and downwards through the 4th foramen to the left corner of the sacrum. By cutting along this line the anterior division of the 3rd sacral nerve will not be divided nor the sacral canal opened. The bleeding up to this time, which is largely venous, is best met by firm sponge or finger pressure; much time will be lost in attempting to seize the bleeding points in the usual way. As soon as the bone is out, the vessels may be closed by forcipressure or, where needful, by under-running. The hæmorrhage comes chiefly from the lateral and middle sacral, the hæmorrhoidal arteries, the bone itself, and a venous plexus on both aspects of the sacrum. The pelvis is now freely opened, and from 6 to 8 inches of the bowel may be removed. The lower part of the gut may be preserved if it is healthy. In any case the rectum is next to be isolated with the finger. Unless matted by extension of the disease, it will readily be shelled out of its bed, posteriorly and laterally.* In Dr. Kelsey's words (*loc. supra cit.*), "the finger cannot be passed completely under and around the gut on account of its size at this point, nor can it be drawn down at all on account of the firm attachments of the peritonæum and the meso-rectum. Any forcible attempt to drag it down at this stage is attended by great risk of rupture and consequent soiling of the wound, and all that should be attempted is gentle isolation on each side by separating it from its loose attachments with the finger, and discovering by touch the extent of the disease to be removed, which can generally be easily done by palpating the tube as it lies in the wound. The next step in the procedure should be the deliberate opening of the peritonæal cavity as near as possible to the bottom of the recto-vesical or recto-vaginal fold. This is not always quickly accomplished,† as the peritonæum is often covered by a considerable layer of connective tissue, and this may be nicked several times at various points before an entrance into the peritonæal cavity is effected. As the operator stands on the left, unless he is ambidextrous, the most favourable point for opening into the cavity will be to the right of the gut, high up in the incision, as the gut is held over to the left side by an assistant. Care must be taken as the knife or scissors are used, not to cut into the gut itself instead of into the sub-peritonæal connective tissue. When once the peritonæal cavity has been opened the right index finger may be passed into the cavity, hooked under the gut from right to left, and forced out of the peritonæum again on the left side of the gut and into the wound. In this way the upper rectum surrounded by its peritonæal layer, with its torn margin, which went to make the cul-de-sac, comes into the wound, and the gut is freed from one of its strongest suspensory ligaments. The rectum is now held from coming down only by the meso-rectum, and, while gentle traction is made upon the gut as I have described, this last obstacle may be cut away, but this, like every other step in the operation, should be done with

* In a male, a full-sized sound must be passed, and every care taken in separating the rectum from the prostate and bladder (p. 1087). If needful, the patient must at this stage be placed in lithotomy position, the sacral wound resting on a large pad of sterilised gauze.

† On the other hand, the peritonæum may be opened, and the opening escape the operator's notice; a danger always to be remembered.

precision and without violence. It must be borne in mind that the nutrition of the upper end of the rectum after the removal of the disease will depend entirely upon the tissue which is now being cut, and this nutrition should be interfered with as little as possible.* The bowel should not be forcibly stripped off from the mesentery and connective tissue, leaving it a mere tube without sources of nourishment, but the mesentery should be divided with scissors at some little distance from its attached border, so that any vessels coming from higher up and running parallel with the gut may be saved. Large veins may be divided between double ligatures. The rectum has now been rendered freely movable and the time has come to resect or amputate the diseased portion. By palpating the gut from without the upper limit of malignant disease can easily be determined. Before dividing the gut a ligature of gauze or an intestinal clamp should be applied above the point of section, and the wound should be carefully protected with packing of gauze. The cut ends should be carefully wiped with pledgets of gauze and dusted with iodoform, and the upper one should be entrusted to an assistant who, by covering it with gauze and holding it out of the way will keep it from infecting the wound. The lower end, held firmly by the operator, must then be rapidly dissected from its remaining anterior attachments, and either cut off below the disease or removed with the anus. In most cases of disease within reach of the finger by rectal examination, the latter will be necessary, and the attachments of the levator on both sides must be cut. Bold and rapid dissection at this stage will save much bleeding.

During all this part of the operation the constant danger of infecting the wound with the contents of the divided bowel must be scrupulously guarded against. Up to this time complete antisepsis is easy, but at this stage it is very difficult, and yet the life of the patient depends most certainly upon its being done successfully, for fouling of the wound with intestinal contents means high fever, prolonged suppuration, and a very high death-rate.

The diseased portion, after removal, should be carefully examined. At least an inch of healthy gut should always be removed above the upper limit of cancer. No hæmorrhage need be feared in dividing the bowel. Unfortunately it is never too well nourished, and a bleeding vessel or two in section is always a good sign.

The next point to be decided is what to do with the upper end of the gut, whether to bring it down to the skin and suture it in the perinæum, or suture it to any part of the rectum which may have been left below,† or to bring it out in the middle of the skin incision and suture it just below the stump of the sacrum. This is always a delicate point, and except in cases of disease high up, where a distinct resection, and not an amputation, has been done, and where some sort of end-to-end union is to be attempted, the location of the new anus will have to depend more upon the nutrition of the upper fragment than upon any preconceived idea of the operator. If the loose end of the gut seems well nourished, and can be loosened from its attachments sufficiently to allow of its being stitched‡ to the perinæum to form an anus in the normal place, it will be a great advantage. If, on the other hand, the segment is pale and bloodless in section,

* With this view, any incisions which are needful should be kept as much as possible to the sides, all the middle part of the mesentery being left intact.

† This course should always be taken when the lower limit of the growth admits of it. As much care must be taken with the sutures (of sufficiently stout sterilised silk) as with enterorrhaphy elsewhere. See also the remarks as to drainage at p. 1089.

‡ With the precautions as to the passage of sutures and drainage given at p. 1089. The use of Murphy's button here is given at p. 1089.

if, in order to get it down at all, the mesentery has been freely divided, it is much safer to bring it out behind, under the cut edge of the sacrum, and attach it to the skin. Of course an anus in the perinaeum is much more satisfactory than one in the sacral region; but next to the danger of infecting the wound during the operation comes the danger of sloughing of the end of the gut after the operation, and infection of the wound from this cause, and it may easily happen that an operation will be fatal in this way which would have been successful had the operator been content with a little less perfect after-result."

The following are other methods of dealing with the upper end of the gut. Mr. F. T. Paul, whose name is well known as an authority in Intestinal Surgery, uses one of his tubes (Fig. 181) as follows. The rectum is first thoroughly freed by opening the peritoneal sac, and dividing as much of the meso-rectum as is necessary. "When plenty of the bowel has been drawn down, the rent in the peritoneum may be loosely closed with a few fine sutures, and a large glass intestinal drainage-tube, plugged with wool, is inserted into the bowel and ligatured above the growths. If the intestine is loaded with faeces the tube had better be introduced below the stricture and forced up,* to the detriment of the specimen, as it is very difficult to avoid some escape of faeces when this powerful bowel is opened under high pressure. The tube having been fastened in, the diseased part is cut off and the stump sutured to the top corner of the wound; the higher the better, as less gut needs to be drawn and the orifice is in a more favourable position for the truss† (*Brit. Med. Journ.*, 1895, vol. i. p. 520)." This method of inserting a tube has the advantages of being simple and rapidly used; it also prevents contamination of the wound with faeces, and further, any large vessels in the intestinal wall are closed with a single ligature. The tube becomes loose about the fourth day. The disadvantage of the tube is that its presence prevents the surgeon from fashioning a smaller artificial anus. But this is a minor point. However well the anus may look at the time, artificial support is almost certain to be required later on, when part of the sacrum and coccyx has been removed. Hence, to prevent prolapsus, and to aid in giving a patient control, such a truss-pad as that of Mr. Paul's will be found a real boon.

Gersun (*Centr. f. Chir.*, 1893, No. 6) advocates treating the upper end of the rectum, if long enough, by torsion, and then fixation of the twisted gut to the skin by suture. The end is grasped by catch-forceps and twisted around its own long axis until considerable resistance is experienced on attempting to introduce the finger into the bowel. He has treated two cases in this way successfully. Mr. Ball (*loc. supra cit.*) has also used it in one case, and recommends it. Dr. Gerster, of New York, has published two cases in which he used it successfully, and thinks that the method deserves preference and extensive trial (*Med. Record*, Feb. 10, 1894; *Ann. of Surg.*, Oct. 1895, p. 499).

Witzel‡ reports (*Centr. f. Chir.* 1894, No. 40) six successful cases in which the end of the rectum was treated as follows. A short incision having been made a little above the free margin of the glutæus maximus, this muscle is perforated with a blunt instrument, and the rectal stump drawn through, the edges of the gut being united to those of the skin.

* This would appear to me to run some risk of carrying up cancer cells on the upper edge of the glass tube, and perhaps infecting the cut edge of the bowel above, when the gut is severed very shortly after.

† *I.e.*, The rectal pad carried by the truss will be more out of the way, especially when the patient is sitting down. Mr. Paul's truss is figured in the above-mentioned paper.

‡ Willems and Rydygier had recommended a similar step before, from experiments on the dead body (*Centr. f. Chir.*, 1893, No. 19; 1894, No. 45).

Hochenegg has made a proposal which may be useful. He invaginates the stump into the lower segment of the gut, drawing it out through the anus, and attaching it to the skin. "This is still further improved by the denudation of the epithelial lining of the anal ring within the sphincter. When practicable, it gives better security against faecal contamination than an ordinary enterorrhaphy" (A. G. Gerster, *Ann. of Surg.*, Oct. 1895, p. 495).

The question of the treatment of the end of the rectum having been decided, the gut placed in the position which it is to occupy, and a source of contamination thus removed, the peritonæum and the wound must be attended to. If the opening in the peritonæum has not yet been sutured—a course which should be taken as early as possible—this is now done, the margins being run together with a continuous suture of catgut, and the peritonæal sac closed by finally stitching the edges to the peritonæal covering of the rectum, if possible. If the patient's condition does not admit of this being done, the surgeon must rest content with closing the rent with fresh strips of iodoform gauze (wrung out of carbolic acid 1 in 20), secured, by sterilised silk, from getting out of reach; and, of course, if the opening into the peritonæal sac has in any way been infected during the operation, it must not be closed, but treated with gauze-plugging after most careful cleansing, and the insertion of a drainage-tube. The deep recesses are then most thoroughly cleansed by irrigation with lot. hydr. perch. (1-4000), iodoform or Jeyes' powder, carefully dusted in, and the chief cavities of the wound filled with drains of iodoform gauze. Oozing must be checked by the irrigation of hot fluids, the leaving on of Spencer Wells' forceps, or plugging. Drainage tubes must be inserted at points where there is obstinate oozing, or pockets difficult of thorough cleansing.*

The Management of Defæcation.—Here there is a divergence of opinion. The majority of surgeons have endeavoured to retard as long as possible the first action of the bowels. This—the bowel not acting till the 6th or 8th day—is facilitated by previously emptying them thoroughly (p. 1091). Others have held that if the bowel can be brought down satisfactorily under the cut sacrum or into the perinæum, and the recesses of the wound kept plugged, an early action of the bowels will be safe. Much must depend on the state of the patient as to flatulent distension, a condition which is very various in different individuals.

(iii) **Excision of the Rectum by the Vagina.**—This method was introduced by Campenon (*France Médicale*, 1894) and Rehn (*Centr. f. Chir.*, 1895, No. 10). The rectum and vagina having been disinfected, the posterior vaginal wall is divided vertically along the middle line, together with the rectum, the incision being carried through the perinæum to the anterior margin of the anus, where it stops or bifurcates, according as the anus is to be removed or no. The bowel is separated from the vagina by careful dissection, and having been freed behind, is divided above the disease between two ligatures applied as a protection against faecal infection. The upper part is drawn out of the way by an assistant towards the symphysis, any tissues holding it down being thus put on the stretch and easily divided. The surgeon then taking the diseased segment treats it either by entire removal, or resection, if the anal orifice can be spared. If the peritonæum is not opened, the growth is cut away, and the bowel drawn down

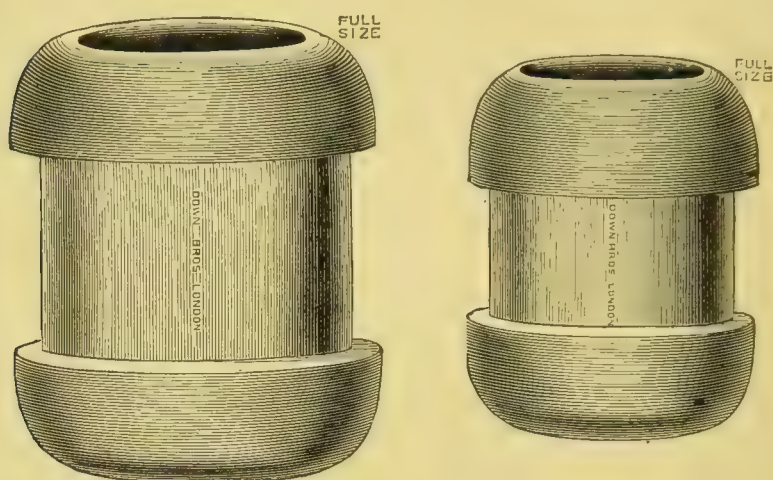
* I have no space to allude to the many modifications of Kraske's operation: parasacral, osteo-plastic, and others. As in many other operations these modifications do not appear to me to be improvements. Moreover, most of them, owing to their additional severity, are quite unsuited to the patients who come to us with rectal cancer. Many of them are mentioned in a helpful article by Dr. A. G. Gerster (*Ann. of Surg.*, Oct. 1895, p. 485).

and sutured. If, however, the peritonæum must be opened, this is easily done, any glands in the meso-rectum removed, and the highest part of the rectum drawn down. The precautions already given as to the treatment of the meso-rectum and its vessels (p. 1093) must be remembered here. The peritoneal opening is, later, to be sutured. The upper end of the gut is sutured to that left just above the anus if possible, the perinæal and vaginal wounds are also sutured, drainage being provided by two tubes placed on either side of the rectum, and brought out in the ischio-rectal fossæ. Rehn's case, an aged woman, of eighty-one, died of septic peritonitis on the third day. Campenon reports a recovery.

(iv) **Removal by the Combined Perinæal and Vertebral Routes.**—After the full account given at pp. 1086 and 1090, no further details are needed here.

(v) **Excision of Rectum by Laparotomy.**—This mode of attacking rectal cancer is justifiable where the growth is situated very high up, at the junction of the rectum and sigmoid flexure, too high for the employment of the

FIG. 299.



Mayo Robson's decalcified bone bobbins (p. 836), latest pattern. Largest size for operation on the large intestine. (Down's Catalogue.)

sacral route, and too low to be reached by the far safer resection from the left iliac fossa (p. 857).

The bowels having been most thoroughly emptied, the bladder is emptied by a catheter, and the abdomen opened by an incision in the middle line, brought as low down as possible. The small intestines are then packed out of the way, and the growth, if possible, brought well up into view. Trendelenberg's position (p. 981) may facilitate this. If adhesions interfere with safe manipulation of the growth, the operation should be abandoned. If it is possible to proceed, the following steps are open to the surgeon: (A) To resect the growth, and to unite the ends with a large sized Robson's bobbin (p. 836, Fig. 299) or Murphy's button (pp. 840, 1089). If the bowels are empty, and if the patient's condition calls for speedy operating, this position is one most favourable to the button. Every possible care must be taken with clamps and the assiduous use of gauze-sponges to secure that no infection of the wound takes place. Another method, Maunsell's (p. 832), which has been successfully used for the removal of an intussusception (Hartley, *New York Med. Journ.*, Oct. 22, 1892) is also applicable to carcinomata.

(B) Paul suggests (*loc. supra cit.*) that in cases where the bowels are not emptied the safer plan would be "to double ligature, and divide the bowel above the growth, taking the upper end out through a small separate wound in the inguinal region, where subsequently a tube could be inserted and an artificial anus established. Then excise the diseased portion of the rectum, and invaginate and close the lower end."

After-treatment.—The chief points here are to keep the wound sweet by frequent syringing with dilute mercury perchloride solutions, the careful insufflation of iodoform, and the keeping all pockets dry. The catheter will probably be required, and a mild aperient may be given about the sixth day, if needed. The finger should be occasionally passed with the utmost gentleness, and after a week or ten days, a bougie, or vulcanite tube (p. 1086).

Question of Colotomy before Excision of the Rectum.—Theoretically, this preliminary step would seem very advisable, as diverting the fæces, and thus a source of decomposition, and as doing away with the need of the use of bougies to prevent contraction (Haslam, *St. Thomas's Hosp. Reports*, vol. xviii. p. 151). From a practical point of view, I do not think a preliminary colotomy advisable, save in an early case (where time has not slipped away), and in one where the disease extends high up. It wastes precious time, and entails two operations in patients too often with poor vitality and too little power of repair. Moreover, the results of excision of the rectum, especially those of Mr. Cripps and Mr. Allingham, show that this preliminary is not needed. Finally, as remarked by Mr. Ball, the advantages of retaining a fæcal outlet in the perinæum are great, so long, of course, as this is not contracted.

Causes of Trouble and Failure after Excision of the Rectum.

1. Shock. 2. Hæmorrhage. This will rarely be difficult to deal with at the time, or met with later, if the surgeon has plenty of Spencer Wells' forceps, good assistants, and, if he does the operation steadily, controlling each vessel as met with.* This, aided by hot injections (p. 1095) and firm sponge pressure, will usually prevent any secondary hæmorrhage. If this should occur, Prof. Macleod's advice should be followed—viz., to pass a large tube into the bowel for the escape of flatus, &c., and to pack carbolised sponges, or strips of gauze, firmly round this. 3. Suppuration. Cellulitis and other septic troubles. 4. Peritonitis. 5. Exhaustion. 6. Recurrence.

After the high removal the above will be present in intensified form. In addition the following must be remembered: (7) Gangrene of the stump of the bowel from over-interference with its blood-supply or retraction of the superior hæmorrhoidal artery. Morestin (quoted by A. P. Gerster, *loc. supra cit.*), *Gaz. des Hôp.*, 1894, p. 326. (8) Sacral fistula. This may be *primary* from defective sutures of the bowel, or *secondary* from the formation of (9) a stricture after resection.† (10) If the fistula does not close it must be submitted to a plastic operation. (11) Prolapsus. This may date to the operation, or to straining afterwards and yielding or bursting of the scar. This tendency will be met by the use of Mr. Paul's truss or one like it (p. 1094).

* Mr. Cripps has shown that, as most of the bleeding comes from vessels situated in the walls of the rectum, dragging down the bowel with a firm grasp will not only greatly facilitate the operation, but also prevent hæmorrhage.

† A. P. Gerster (*loc. supra cit.*) holds that resection has been invariably followed by a stricture, no matter what form of approximation—suture, Murphy's button, or invagination—is used. Frequent digital examination is indispensable; the stricture, if detected early, will yield to systematic dilatation with a bougie.

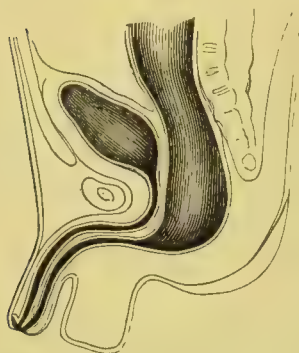
IMPERFORATE ANUS. — ATRESIA ANI. — IMPERFECTLY DEVELOPED RECTUM (Figs. 300–306).

A surgeon, when called upon to explore these cases, will do well to bear in mind the following natural and practical classification, because on this depends his treatment :—

Two Main Varieties : A. Cases in which no normal anus exists—*Imperforate Anus*. B. Cases in which a normal anus exists, but the gut is obstructed higher up, or undeveloped—*Imperforate Rectum*.

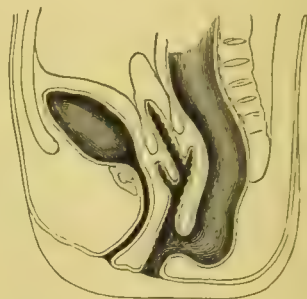
A. *Imperforate Anus*. 1. Anus partially closed—(a) by adhesions of epithelial surfaces, as occasionally happens in the labia of a female infant ; (b) by a membrane. 2. Anus completely closed, but only by a membrane. 3. Anus completely

FIG. 300.*



Anus absent. Rectum opening by fistula, close to urethra. (Rushton Parker.)

FIG. 301.



Anus absent. Rectum communicating with vagina. (Rushton Parker.)

closed by a membrane, but a fistula exists—(a) on the surface of the body (e.g., the raphe of the scrotum) ; (b) into the vagina (Fig. 301) ; (c) into the urethra or bladder (Figs. 302, 306). 4. Anus imperforate and the rectum deficient as well.

B. Anus in natural position, but the rectum is deficient†—(a) the rectum is deficient for a short distance only, and separated from the anus by a cul-de-sac (Fig. 303) ; (b) the rectum is deficient for a long distance, or entirely (Fig. 305).

Treatment.

A. Those in which no natural anus exists.

1 and 2. If the atresia be due to epithelial adhesions, or to a more or less complete membrane, the former should be broken down and the latter snipped away with scissors, and the opening kept patent by a small piece of oiled lint, the nurse's little finger being introduced twice daily.

3. If the anus be imperforate, and a fistula open (a) on the surface of the body, (b) into the vagina, or (c) urethra :

(a) A probe is passed from the skin-fistula (e.g., in the scrotum) towards the proper anal site ; it is then cut down upon and the opening established in the proper position.

* This, and the next six figures, are taken (with a few alterations) from an article by Mr. Rushton Parker (*Liverpool Med. Chron.*, July 1883).

† As Mr. Holmes has shown, these cases are important, as they are liable to be overlooked till considerable distension has taken place.

(b) If the fistula open into the vagina, the treatment will vary somewhat with the urgency of the case, the size of the opening, and the age of the child.

Thus, if the opening be very small and the retention urgent, a silver director should be passed through the vaginal fistula back to the proper site of the anus, and there cut down upon. If the bowel is within reach, it should be drawn down and stitched *in situ*. The orifice should be kept patent.*

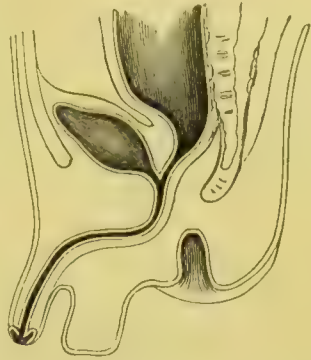
If, owing to the size of the vaginal fistula, there is not much retention, and especially if the child be not very young, the following operation may be performed, after the method of Rizzoli (quoted by Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 788): An incision is made from the vulva to the coccyx in the middle line, the rectum found by most careful dissection, separated from the vagina, and then brought down and fixed in its natural position. To aid in finding the rectum, a probe should be passed from the fistula.

After the rectum has been brought down and secured, the incision between the anus and vulva is united to form a new perinæum.

(c) Fistula into the urethra or bladder. Two questions here arise, How high up is the communication? How much of the bowel is deficient?

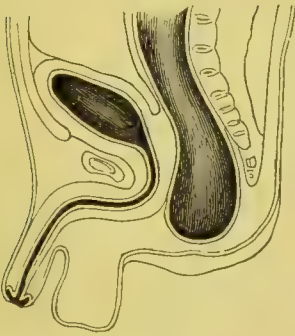
If the perinæum seem fairly developed, if the ischial tuberosities are not in close contact, if any bulging can be detected at the natural site of the anus, the

FIG. 302.



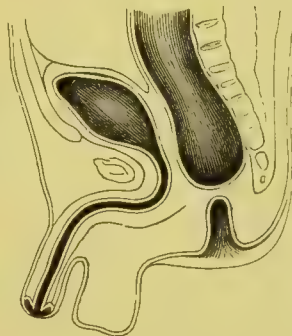
Anus ending in a cul-de-sac. Rectum opening into urethra far back. A case for Littré's operation. (Rushton Parker.)

FIG. 303.



Anus absent. Rectum could be reached by dissection. (Rushton Parker.)

FIG. 304.



Anus ending in cul-de-sac. Rectum readily reached from this. (Rushton Parker.)

communication is probably recto-urethral, and an attempt may reasonably be made to find the bowel from the perinæum. If it is found, and can be brought down, an attempt may be made to separate it from the adjacent urethra, but usually the surgeon will have to be satisfied with a free opening, and with keeping this patent, so as to encourage the urethral communication to close. If there

* In such a case, though an anus is established in the proper position, it is very doubtful if the vaginal fistula will close, and a further operation will probably be required later on. Plastic operations should not be tried too early on account of the softness of the tissues and the liquid condition of the feces.

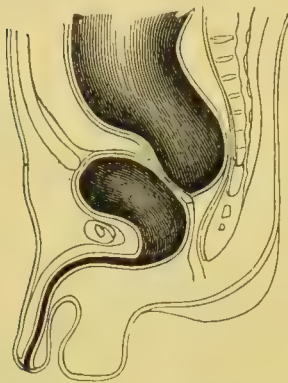
appear no probability of the bowel being within reach, or if this cannot be found, Littré's operation should be performed (pp. 686, 701).*

4. Anus absent and rectum deficient as well. Here the chief question is how far upwards an exploratory operation may be safely conducted.

External evidence. Genitals far back and close to the coccyx, and ischial tuberosities close together, point to absence of the rectum.

In most cases the surgeon begins by exploring. The child being under the A. C. E. mixture and in lithotomy position, and a small sandbag placed under the sacrum,† the surgeon, seated at a comfortable level, makes a free incision from the position of the anus back to the coccyx. Keeping exactly in the middle line, and opening up the cellular tissue with his finger-tip, aided by a scalpel and director, the surgeon works backwards towards the concavity of the sacrum, constantly taking note

FIG. 305.



Anus absent. Rectum ending high up. A case for Littré's operation. (Rushton Parker.)

FIG. 306.



Anus and rectum deficient, the bowel ending in the bladder. (Rush-ton Parker.)

with his finger-tip of the depth to which he has got, while an assistant aids in bringing down the bowel by supra-pubic pressure.

As a rule, 2 inches are a sufficient depth in a new-born child. If still in doubt whether to proceed or no, the surgeon may make a careful puncture with a morphia-syringe backwards, and note the condition of the point; no puncture with a trocar is justifiable at this depth.

Points to bear in mind.—1. The rectum may end at the brim of the pelvis. 2. If it end lower down, it may be floating with a long meso-rectum. 3. Though the rectum may end within reach, the peritonæum may, and not unfrequently does, extend low down on the bowel. 4. Even if the rectum is successfully opened high up, without opening the peritonæum, fatal cellulitis may be set up by the escaping fæces, or by the attempts to keep the bowel patent.

If the above exploratory operation fail, inguinal colotomy or Littré's operation should be resorted to, p. 701.

B. *Imperforate Rectum.*—The treatment here will be an exploratory operation, followed, in case of failure, by Littré's operation (p. 701).

* If the child survive, the bladder must be kept carefully washed out if any fæces still find their way into it. Thus, in a case of Mr. Clutton's (*St. Thomas's Hosp. Reports*, vol. xi. p. 84), a child about a month old died, sixteen days after Littré's operation, of suppurating kidneys, due to the offensive purulent urine.

† The bladder may first be emptied with a catheter.

CHAPTER XV.

RUPTURED PERINÆUM (Figs. 307, 308).

THE following account is taken from my colleague, Dr. Galabin : *

A. Operation for Partial Rupture (Fig. 307).—The patient is placed in lithotomy position. The need for assistants to support the thighs is avoided if a "Clover's crutch" is used.

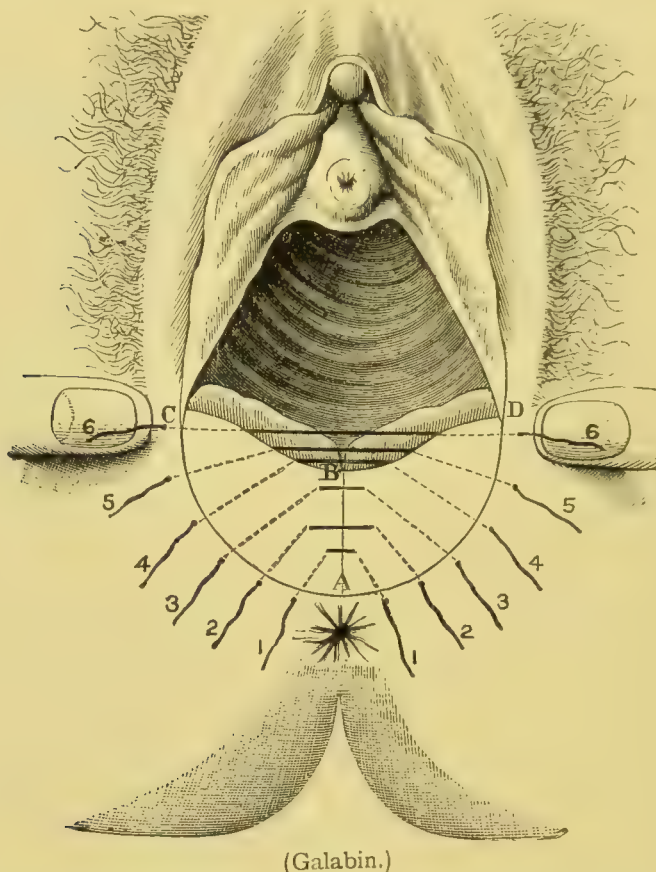
"The extent of surface to be freshened is indicated, to some extent, by the cicatrix left by the rupture. It is well, however, to go a little beyond the limits of this in all directions, especially up the median line of the vagina and towards the lower halves of the labia majora, both in order to secure, if possible, a perineal body somewhat larger and deeper than the original one, and to allow some margin, in case the surfaces do not unite completely up to the edges. To put the mucous membrane on a stretch, an assistant at each side places one or two fingers on the skin of the thigh and draws the vulva outwards (Fig. 307). The skin just beneath A, in front of the anus, may also be seized by a tenaculum and drawn downwards. If still the mucous membrane is not sufficiently on the stretch, from laxity of the vagina, the posterior vaginal wall, some distance above B, should be seized by long-handled tenaculum-forceps and pushed upwards. Incisions are then made through the mucous membrane from B to A, in the median line of the vagina, and from A to C and D through the junction of mucous membrane and skin. These should not be extended in the direction of C and D further than the lower extremity of the nymphæ at the utmost. There are then two triangular flaps, ABC and ABD. These are to be dissected up from the apex A towards the base BC and BD, the corner of the mucous membrane at A being seized with dissecting forceps. The dissection should not be deeper than necessary, and if it is done with the knife the surfaces are more ready to unite. If, however, there is much tendency to bleed, scissors may be used. The apices of the flaps are then cut off with scissors, leaving an upturned border along BC and BD. When the surfaces are drawn together these borders form a slightly elevated ridge towards the vagina, and if there is any failure of union just along the edge they fall over and cover it.

"The best material for sutures is the silkworm- or fishing-gut, which should be stout, of the thickness used for salmon flies. It may be stained with magenta, to render it more easily visible. This has all the advantage of silver wire, as being non-absorbent, while, at the same time, it is easier to manipulate, and the exposed ends do not cause discomfort after the operation, like those of wire. The sutures are placed as shown in the figure. The most convenient needle is a slightly curved one, not too thick, mounted in a handle. This is passed in, unthreaded, rather close to the edge of skin, brought out on the raw surface, then threaded with the end of the suture, which is so drawn through. By passing

* *Diseases of Women*, pp. 130, 381. Any one making trial of this method will agree with me as to its simplicity and excellent results.

the needle in the same way on the other side, the other end of the suture is drawn through. Another mode is to use a more curved needle, and to bury the sutures, 1, 2, and 3, in the tissues throughout their whole course. If, however, they are brought out in the centre for spaces alternately short and long (Fig. 307), the surfaces are more easily brought into contact at all levels without undue tension. In passing sutures 4, 5, 6, the needle should be brought out precisely on the margin along which the border of mucous membrane BC, BD, are turned up from the vagina, not passing through the mucous membrane itself. The sutures are then tied in the order of the numbers from 1 to 6, care being taken that the surfaces are brought just sufficiently into apposition, and that no

FIG. 307.



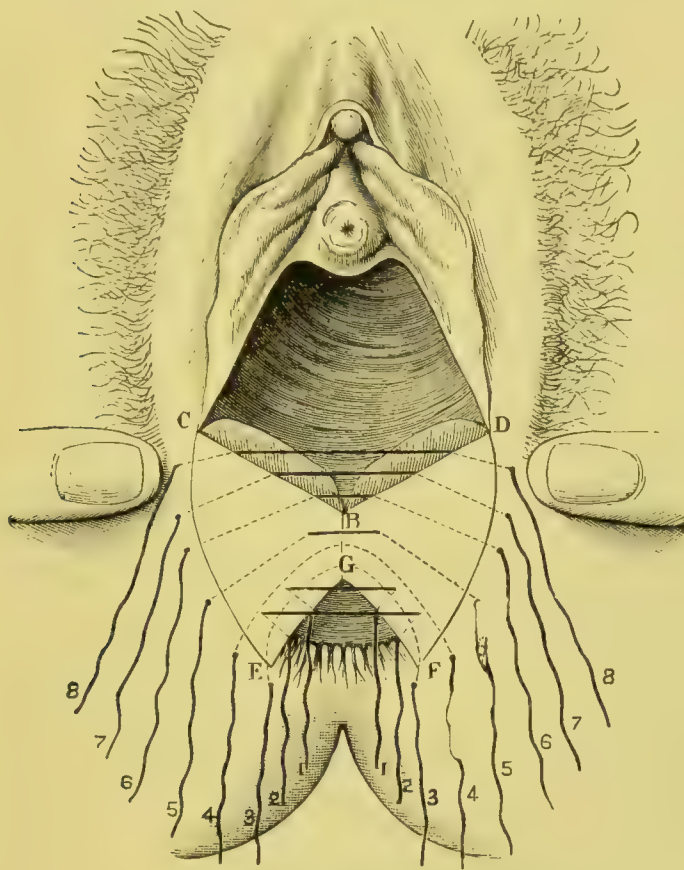
clots or blood are left between them. The bleeding, if any continues, is arrested by bringing the surfaces together, and if they are properly united there will be no secondary hæmorrhage, unless the sutures begin to cut from excessive tension. The sutures may be left in from seven to ten days."

Operation for Complete Rupture (Fig. 308).—The preliminary steps are taken as above. "A point B in the median line of the vagina, a sufficient distance above the apex of the rent in the septum, is taken, and an incision through the mucous membrane is made from B to G, and from G to E and F along the edges of the septum, between the rectal mucous membrane and the cicatrix. Incisions are also made through the skin from E to C and F to D, so that the freshened surface may extend somewhat beyond the limits of the cicatrix. C or D not to be higher than the lower extremities of the nymphæ. The quadrilateral flap EGBC is then seized at E by dissecting forceps, and dissected up with the knife from the angle E, and afterwards from the angle G, towards the base BC.

While this is done, the parts are kept on the stretch by an assistant drawing down the skin below *E* with a tenaculum. The flap is then cut away with scissors, except an upturned border, which is left along *BC*. The flap *FGBD* is treated in a similar manner. If, as is usual, the ends of the sphincter at *E* and *F* have retracted from the margin of the cicatrix, it is well to cut away with the scissors a narrow strip of rectal mucous membrane, generally somewhat everted, a short distance from *E* and *F* towards *G*, so as to bring the freshened surface to the ends of the sphincter.

"Sutures of silkworm-gut are then applied in the following manner: First, rectal sutures, either two or three, according to the extent of the rent in the

FIG. 308.



(Galabin.)

septum, are applied. These are destined to be tied in the rectum, and the ends left projecting through the anus. They are best applied with a half-curved needle, held in a holder. The needle is passed in a little distance from the margin of the rent, and brought out almost at the very edge of the rectal mucous membrane, on the line *GF*. The needle is then threaded at the other end of the suture, and that is drawn through in the same way from without inwards, on the margin *EG*. Next two sutures at least are passed completely round through the remnant of the septum, by means of a curved needle, not too large, mounted in a handle. This is passed unthreaded, and draws the suture back with it on withdrawal. The first of these (3, Fig. 308) is passed in somewhat behind and below the angle *F*, so as to take up, if possible, or at least go quite close to, the end of the divided sphincter, and is brought out in a similar position near *E*. Thus, when tightened, it brings together the ends of the sphincter, drawing it into a

circle; but it often brings into apposition, not so much the freshened surfaces above as the unfreshened rectal mucous membrane. This serves as a barrier to keep out faecal matter, while the next suture (4, Fig. 308) aids the rectal sutures in uniting the freshened surfaces. The remaining sutures are passed as shown in the figure (5-8, Fig. 308) by a slightly curved needle mounted in a handle, in the same way as in the operation for incomplete rupture (Fig. 307). The needle, unthreaded, is passed in pretty close to the edge CE or FD, is brought out (except in the case of suture 5, Fig. 308) on the line where the margin CB or DB is turned up, and draws one end of the suture back with it, the other end being afterwards drawn through in the same way. The effect is, that when the sutures are tightened, the margins BC, BD are turned up into a slight ridge towards the vagina, and afterwards fall over and cover any portion of the vaginal border which does not unite quite up to the edge. Suture 5 (Fig. 308) may either be buried throughout, or brought out for a very short space near the median line BG.

When all the sutures are in place, the sponge* is withdrawn from the rectum, and the rectal sutures are tied first. Care must be taken to draw up the whole of the slack in the centre, and bring the edges EG, FG perfectly together. This will approximate the ends of the sphincter to a great extent, and the approximation is completed by tightening suture 3. The remaining sutures are then tied in the order of the numbers, care being taken to allow no clots or blood to remain between, and to tighten them just enough to bring the surfaces in contact. The ends of the rectal sutures may be left moderately long, to distinguish them, the rest cut pretty short.

The perineal sutures are removed in seven days. The rectal sutures may be left from ten to fourteen days longer, till the perinæum is consolidated. They are then removed through a small rectal speculum, care being taken not to break down any of the union in passing it. By this operation the anus is generally much more completely restored than by the use of quilled sutures, or the plan of making deep lateral incisions to relieve tension. If there is much resistance to bringing the surface together, the only thing required is to use more numerous sutures, so as to diminish the tension on each.

In some cases, by the primary operation after labour, only superficial union is secured, and a recto-vaginal fistula is left close to the part united. The best plan is then to cut through the bridge of union with scissors at the time of the operation, and then proceed as in the case of complete rupture. This is the only way to secure a firm and thick perinæum, and is less likely to fail than an operation on the fistula alone."

* This, secured with tape, is introduced into the bowel, to prevent the descent of any faeces left by an enema.

CHAPTER XVI.

OPERATIONS ON THE OVARY.

OVARIOTOMY.—REMOVAL OF THE UTERINE APPENDAGES.

OVARIOTOMY.

ONE or two **practical points** will be alluded to before the operation itself is described.

Question of Adhesions.—If there is free mobility of the cyst from side to side, there are no parietal adhesions. In testing this, both hands should be employed. Does the tumour descend with a deep inspiration? Here a good light and careful percussion are needed. These movements are seen best when the surface of the cyst is uneven. Presence of intestine in front of the cyst can be made out by careful palpation and percussion. The history of pain (pointing to attacks of local peritonitis) and any previous tappings, together with the size and duration of the tumour, will also help in deciding as to adhesions. But it is often impossible, before the abdomen is opened, to say whether the operation will be easy or no.

Date of Operation.—The patient should be warned of the importance of an early one. The certainty of increasing adhesions and difficulty, the greater annoyance of the tumour (especially in unmarried women), the attacks of peritonitis with their pain, the risk of twisted pedicle and its results, must all be remembered. The patient must decide between living a year or two with the above risks before her and the growing misery of the tumour, and submitting to an operation the risks of which are but small, nowadays, in an average case which is taken early.

The condition of the viscera, kidneys, lungs, &c., the habits of the patient, her amenability, her digestive powers, must all be considered.

The *amount of skill of the surgeon*, though a delicate matter, must also be mentioned. No one should operate on these cases who has not had good opportunities of seeing others operate frequently, and no one should undertake a case whose ovariotomies are, at the most, likely to be but two or three in his lifetime.

Preparation of the Patient.—For a week before, the patient should be kept quiet, have a gentle aperient every other night, and a bath once in the twenty-four hours. The solids of the diet should be somewhat restricted, and all the food taken easily digested and nutritious. Sufficient fluids should be given to ensure a healthy clearing out of the kidneys, a little sound spirit, well diluted, being as suitable as any stimulant. If needful, one of the salts of lithia may be given three times a day. On the morning of the operation an enema should be given, a light breakfast taken early, and some good beef-tea or soup about 11 if the operation takes place about 2 P.M. When the patient, warmly clad, especially as to her extremities, comes in to take the anæsthetic, only two or three faces that are familiar to her should be present. It is best to begin with the A. C. E. mixture, but ether should always be at hand to go on with, save in those cases where the condition of the lungs is against this course. When the patient is under the anæsthetic, a catheter should always be passed, but not by the operator or any of his immediate assistants.

Preparation of Instruments, &c.—The room, which has been thoroughly cleansed, and not rendered too comfortless for the sake of ventilation, &c., should have a temperature of about 65°. A good light, and one likely to last, should be secured. The table should be sufficiently high to save the operator stooping, and only just wide enough to hold the patient comfortably. A dozen new Turkey sponges, chosen for their even softness of texture, should be thus prepared:*

All the sand is got out of them by beating them over a sheet or towel, a process which requires to be repeated again and again by trusty hands. When they are really sandless, they should be placed in carbolic acid solution (1 in 20, and to be kept renewed), and in a solution of 1 in 40 for a few hours before the operation. During this they should be cleansed in a solution of the same strength.

Four flat ones (not too large) should be provided. A few small sponges ready for use on holders leave no excuse for the dividing of sponges during the operation, a course to be unhesitatingly condemned. It is well to record the number of sponges and Spencer Wells' forceps on a slate.

The following should be in readiness: Two scalpels; blunt-pointed bistoury; steel director; Key's director; twelve pairs of Spencer Wells' forceps; omentum clamp-forceps; cyst-forceps; Spencer Wells' vulsellum-trocar† and tubing; blunt-pointed scissors; needles, both twelve straight, two being threaded on each suture of stout silk for closing the abdominal wound, and fine ones, both straight and curved, for underrunning any bleeding point or

* Mr. Doran (*Ann. of Surg.*, May 1888), in a very practical paper on "The Details of Ovariectomy," points out that, if the sponges are whitened as well as cleaned in a solution of sulphurous acid (1 in 5 of water), they will readily show any foreign matter clinging to them. He advises that a sponge be kept in Douglas' pouch during the operation.

† One or two smaller trocars should also be in readiness.

introducing fine sutures if any of the contents of the abdomen are unavoidably injured; two aneurism-needles; plenty of silk and chromic-gut ligatures of varying sizes, and the material carefully prepared, including some stout enough for the pedicle; two pairs of dissecting-forceps; a probe; dressing-forceps; drainage-tubes, both glass and rubber; Paquelin's cautery; some solid perchloride of iron; abundance of carbolic acid and mercury perchloride lotion; a foot-pan to stand under the table; two others to wash the sponges in; a laryngeal mirror or electric lamp. The instruments should stand, in two trays or pie-dishes, on a small wheel-table close to the operator's right hand; the ligatures and sutures should be in separate porringers, all covered with carbolic acid (1 in 40). Tampons of iodoform gauze, of varying size, so as to shut off any part of the peritonæal sac while adhesions are being dealt with, should also be at hand, kept in the same solution.

In addition to the anæsthetist, three assistants should be present—one to tie off vessels, &c., as they are taken up, help with the tumour, &c., another to keep the edges of the wound over the intestines if needful, and a third to hand instruments. Two nurses should be at hand to cleanse the sponges. Within reach of the operator should be a porringer of mercury perchloride solution (1 in 3000) for him to dip his hand in occasionally. The abdomen of the patient should be shaved and cleansed (p. 657) just before the operation; mackintoshes covered with towels wrung out of carbolic acid (1 in 20) are carefully packed around so as to cover all save the vicinity of the field of operation.*

The Operation.—An incision,† reaching from just below the umbilicus to within 2 inches of the pubes, is made in the linea alba‡ rapidly down to the peritonæum. Before this is incised, Spencer Wells' forceps are applied to every bleeding point.§ The peritonæum, readily recognised, when healthy, by its delicate fasci-

* Irrigation should be used until the peritonæum is opened. After this the surgeon must rely on everything that comes in contact with the peritonæal sac being rendered most strictly aseptic. Finally, no amount of attention to anti-septic details will replace personal experience, fertility in expedients, and resourcefulness in meeting difficulties.

† Where the cyst contains much solid material, the incision should at once be made very free, beginning above the umbilicus. Mr. Doran (*loc. supra cit.*) thinks a mistake is often made in not bringing the incision near enough to the pubes, which may cause much trouble when the pedicle has to be drawn out, and greatly impede a thorough exploration of the pelvis. With regard to wounding the bladder, the operator should trust only to the aid of a catheter, and the appearance of structures exposed.

‡ If the linea alba is missed and the rectus or pyramidalis cut into, the middle line will be found by pushing a probe inwards under or through these muscles. But in case of difficulty the peritonæum should be reached by tearing cleanly through muscular fibres with a steel director.

§ Forci-pressure should be trusted to as much as possible, the forceps being left on for five or ten minutes. Many ligatures weaken the cicatrix, and may cause actual suppuration.

culation and translucency, is carefully hooked up so as to include nothing else, and opened. Occasionally large veins lie superficial to it, just in the operator's way. All bleeding must be arrested, especially at the lower angle of the wound. The peritonæum is next slit up on two fingers, to the length of the incision, and the pearly glistening cyst comes into view. The above applies to an easy case without parietal adhesions. But if the peritonæum is thickened and adherent to the cyst, there may be the greatest difficulty in deciding when this is reached. The best way to solve the doubt is to prolong the incision upwards to the left of the umbilicus, till a spot free from adhesions is found. While the operator is in uncertainty, on no account are apparent adhesions to be separated, or the parietal peritonæum may be detached from the abdominal wall. When the cyst is reached, it is examined with two or three fingers, which will give some information as to visceral and posterior adhesions. As soon as the cyst's surface is really made out it is best to tap it. To separate the adhesions before tapping it is, in Mr. Thornton's words (*Dict. of Surg., loc. infra cit.*), "bad practice, because, if they are separated while the parietes and cyst-wall are both stretched by the fluid, all the little vessels in them bleed, and very serious hæmorrhage may occur out of sight during the subsequent emptying of the cyst; whereas, if the cyst be first tapped, the contraction of both parietes and cyst wall closes the smaller vessels."

The cyst is tapped* by carefully plunging in a Spencer Wells' trocar, then guarding the point with the inner tube, and attaching the claws to the cyst so as to keep this on the trocar as forward traction is made. If it is clear from the bulk of the cyst remaining unaffected that it is multilocular† or solid, the surgeon must reduce it before attempting to extract it. If it be multilocular, it must be tapped again in two or three more places, by removing the trocar, and closing the puncture with cyst-forceps, and then, while the cyst is dragged forwards and steadied, the first trocar or a smaller one is thrust in at other spots where fluid is still present. This is better practice than thrusting the trocar from the first puncture into other parts of the cyst in the dark. If the bulk of the cyst be solid, the trocar puncture having been enlarged, and clamp-forceps firmly keeping forwards the edges the surgeon first

* Great care must be taken to ensure that all the fluid escapes well away from the wound, and, with sponges under the trocar, and by turning the patient on her side, to prevent any contamination of the peritonæal sac. I have met with an unusual complication at this stage. Though the greater part of the tumour was clearly fluid very little could be made to escape through the trocar. The incision being enlarged and the cyst gradually brought outside numerous soft putty-like masses were found floating in the usual ovarian fluid. These had blocked the trocar. The upper part of the cyst was solid and contained the usual hair and teeth of a dermoid. The patient made an excellent recovery.

If the cyst is multilocular, the largest should be first chosen (Galabin).

introduces two or three, then perhaps all the fingers of one hand, and scoops out the solid material till the bulk of the cyst is sufficiently reduced to come through his incision. I prefer to enlarge the incision upwards sufficiently to allow of the mass being brought out, its long axis being tilted into that of the wound. During the tapping one or two sponges must be kept under the trocar to prevent leakage into the peritonæal sac.

If the wound requires enlargement, this is best done with a blunt-pointed, straight bistoury, and the use of two fingers as a director, the incision being carried to the left of the umbilicus so as to avoid any still open vessel in the round ligament. As the cyst comes forward any adhesions must be dealt with. The commonest are to the omentum, the small intestine, and transverse colon. The separation must be effected, bit by bit, with the finger-nail or steel director, each bleeding point being caught with pressure-forceps and tied. Another method is to under-run bleeding points, especially any obstinate ones in the parietal peritonæum. Any persistent oozing may be touched with Paquelin's cautery or the iron perchloride. Mr. Thornton thus advises the use of the latter :

"The surfaces to be touched should be dried with a sponge; then a small sponge, well wrung, should be smeared lightly with the solid perchloride, and firmly pressed against the bleeding surface till the oozing stops; a large flat sponge should be spread under the surfaces thus treated, to prevent any of the acid serum, which runs away immediately after the application of the iron, getting on to the intestines. Oozing surfaces in the pelvis are treated in the same way, the intestines being first drawn out of the way and protected by sponges."

While adhesions* are being dealt with, the sides of the wound must be kept well approximated by an assistant, and a sponge placed in the lower angle to prevent fluid entering here. As the cyst comes forward, its posterior surface will either be free or attached to the small intestine. In either case the projection of any coils must be prevented by the use of a large flat sponge wrung out of mercury perchloride solution (1 in 3000), green protective or iodoform gauze tampons, or a clean towel cut in two and soaked for half an hour in a 1 in 20 solution of carbolic acid.

When the cyst has been sufficiently brought outside, the pedicle is dealt with by the intra-peritonæal method.†

* Sometimes these are so broad as to require separation bit by bit, and the application of a pressure-forceps to each bleeding point.

† Mr. K. Thornton (*Dict. of Surg.*, vol. ii. p. 155) thus describes the method of *enucleation* for cases with no pedicle: "Cases are met with in which the base of the tumour is so situated between the layers of the broad ligament or so pushes its way under the peritonæal covering of the uterus, or of the pelvic floor, that cautery and ligatures are alike inapplicable, or, at least, ligatures can only be applied after much previous enucleation. When this is the case, an incision should be made through the peritonæal capsule of the tumour, and careful enucleation practised with the fingers. It is well, if possible, so to direct this process as to isolate, at an early stage, the parts of the broad ligament which

The centre of the pedicle being found by unfolding it, an aneurism-needle loaded with stout silk (No. 1) is made to perforate it here at a spot devoid of vessels. The loop of silk being drawn through and the needle withdrawn, the loop is cut, and the two ligatures tied firmly round the two halves of the pedicle. To make the silk hold in a stout pedicle, it is well to loop the ligatures round some blunt instruments, so as to tie them with sufficient force. When they are both tied, one is cut short, while the other is thrown round the whole pedicle and tied again. The cyst is then cut away not more than $\frac{3}{4}$ inch, and not less than $\frac{1}{2}$ inch from the ligatures. When this is done, the cut end is

FIG. 309.

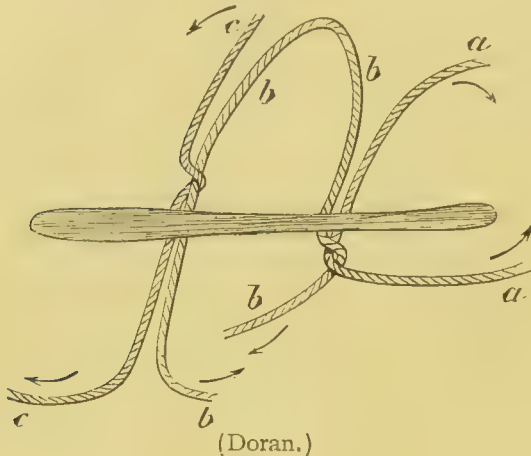
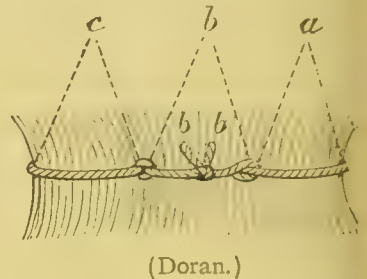


FIG. 310.



carefully examined, and any point that oozes tied with fine silk or chromic gut. The pedicle is then allowed to drop in, and the finger, following it down to the uterus, finds and hooks up the other ovary. If this is found enlarged, it must be removed. When the pedicle is very broad, a second or a third transfixion will be needed. The second must be thus performed: The thread for the outer loop (*a*, Fig. 309) is twisted, on one side of the pedicle round the outer thread (*b*), then the outer loop is tied. The pedicle-needle (a long un-handled one with a large eye is the

would form the pedicle in an ordinary case, and then to transfix and tie them in the usual way. After this, the chief blood-supply of the tumour is under control, and the rest of the enucleation may be more rapidly and boldly made. Shreds of capsule which bleed should all be secured in pressure-forceps, and ligatured with or without transfixion after the tumour is completely shelled out. Usually, the capsule falls together and no oozing occurs, but sometimes this is troublesome from a large surface, and Paquelin's cautery or the solid perchloride of iron may be applied (*vide supra*). . . . In performing these enucleations, the operator must always bear in mind the fact that the capsule is often the pelvic parietal peritonæum, and that he is constantly brought into dangerously close relations with bladder and ureters, rectum and sigmoid flexure, or cæcum and appendix (the latter is very frequently adherent in these cases), and, as it bleeds very much when torn, requires careful handling and often repair with a fine needle and silk. The large iliac vessels are also occasionally incorporated with the capsule."

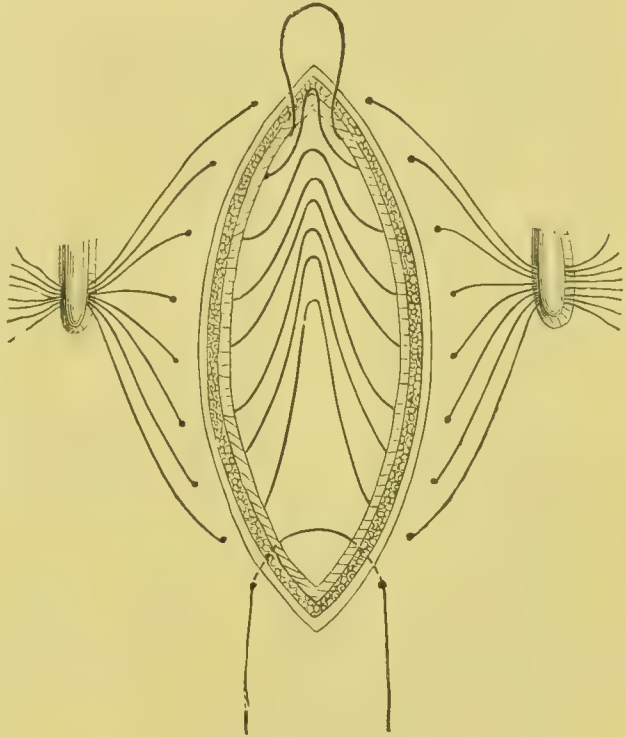
best) is then threaded, first with a single ligature (*c*), and then with one end (*b*) of the untied thread already passed through the pedicle. The transfixion is then performed (Fig. 309). The third thread (*c*) must be once twisted around the second (*b*); this is best done, perhaps, on the side where (*b*) forms a loop (Fig. 309.) Then, on the opposite side, the two free ends of the second thread (*b*) are firmly tied. The ends of the third thread (*c*) are then tied on the inner side of the pedicle. The threads will then lie as in Fig. 310, firmly interlocked and holding the pedicle tightly. Should a third transfixion be required, the third thread, instead of being tied, must be threaded on the needle in company with a fourth, and the process just described repeated, care being taken to interlock the threads as before. If this precaution be not taken, the unlocked threads pulling in different directions will tend to tear the pedicle apart at the point of transfixion, and vessels may easily escape being commanded. As each of the above loops is tied, the ends of the thread must be cut short or needless confusion will be entailed.

The operator now scrutinizes the parts, removes any jagged omentum, arrests any still bleeding points, and takes out any sponges which he may have inserted, and has them all counted.

The next step is the "toilet," to sponge out most thoroughly the pelvis, the spaces in front of and behind the uterus, and those on either side of the vertebral column. This is effected by introducing again and again warm aseptic sponges, well wrung out, on clamp-forceps, until they return dry and colourless.

A flat sponge being now introduced to catch any blood, the abdominal wound is closed by means of sutures of stout silk with a needle at either end. Each needle is passed from within outwards through the peritonæum first, and then through the skin at least $\frac{1}{4}$ inch from the edges of the wound. The sutures are inserted about $\frac{1}{2}$ inch from each other, and a few of horsehair

FIG. 311.



(Doran.)

may be put in quite superficially as well. Before they are tightened, the flat sponge is withdrawn. When they are all tied,* a little iodoform is dusted on, the abdomen cleansed, and dry-gauze dressings (sal alembroth or iodoform) applied.

When all the threads have been introduced they are collected near their ends, on either side, with pressure-forceps (fig. 311). The operator then parts the sutures, hooking them up and down, so as to obtain free access to the abdominal cavity without any risk of pulling out a suture. The flat sponge is now withdrawn, and the wound closed, or the peritonæal sac wiped out with sponges, or "flushed" (pp. 809, 818), if needful.

The question of drainage† must depend mainly upon the completeness of the "toilet" of the peritonæum, the probability of any subsequent oozing, especially if deep in the pelvis, and the possibility of any septic fluid having entered the peritonæal sac. A glass tube (p. 802) should be the one used, one end resting at the bottom of Douglas' pouch without pressing on the rectum, the other passes through a thin sheet of india-rubber, its neck being gripped firmly by a button-hole in this. It is well to pass one or two sutures, in the usual way, through the abdominal wound, above and below the tube, and to leave these to be tied when the tube is removed. Some gauze, changed frequently, is placed in and around this end of the tube.

Incomplete Ovariectomy.—The surgeon may be compelled, very early in the case, to abandon his operation and to close the wound on account of malignancy, or of adhesions between the cyst and important viscera. In other cases, having gone farther, he may find the base of the cyst, whether encapsuled or no, irremovable, deep in the pelvis, and adherent to the ureter, large vessels, or adjacent viscera. The surgeon must then suture the cut edge of the base of the cyst and what remains of the capsule to the abdominal incision. Before doing this he must check all hæmorrhage, inspect any possibly damaged viscera, and cleanse carefully the back of the tumour and the parts behind it. If the abdominal wound is a long one, the upper part must first be closed by sutures. The cut edge of the cyst must then be carefully sutured to the abdominal incision, the sutures being passed through the peritonæum, about $\frac{1}{4}$ inch from its cut edge, so as to bring it in contact with the cyst-wall. In doing this the peritonæal sac must be entirely shut off from the wound. Adequate drainage must be provided. Mr. Doran points out that the operator must endeavour in these cases to remove all solid growth from the piece of cyst left behind, else both sepsis and recurrence will be very probable.

* They should not be tied too tightly, else points of suppuration will result.

† Mr. Greig Smith's words should be remembered: "The question of drainage is a very difficult one to speak about in theory. In practice, a good rule to follow is—'When in doubt, drain.'" On the question of "the toilet" of the peritonæal sac, and drainage I would refer my readers to some remarks at p. 817.

Accidents during Ovariectomy.

1. Fainting. This will be best met by preventive treatment. If it occur during the operation, ether must be given, the head lowered, the patient kept warm, and brandy given subcutaneously.

2. Vomiting. This chiefly harasses by straining the intestines out of the abdomen. If prolonged, the operation must be completed as soon as possible, an assistant keeping the abdominal walls pressed against the viscera, or dragging the former forward after pulling them between his finger and thumb.

3. Separation of the parietal peritonæum. This has already been spoken of, p. 1109.

4. Rupture of the cyst. This accident may be expected when the walls are thin, rotten, or softened by recent peritonitis. In such cases careful handling, keeping suspicious spots well out of the wound or packed around with sponges, additional care with the "toilet," and irrigation with hot boiled water and the use of a glass tube if any fluid has got into the peritonæal sac, are indicated.

5. Injury to viscera. Of these the bladder, small intestine, rectum, and ureter are most likely to suffer. In the case of the bladder, the surgeon must decide, by the time of the injury and the amount of damage, as to whether he will complete the operation after closing the wound, or defer it. In the case of injury to the intestine the directions given at pp. 826, 861, 886, will be found useful. In the case of the ureter it will usually be wisest to ligature the lower end, if possible, bring the upper out of the wound, and to perform nephrectomy subsequently, as in Simon's case.

6. Leaving in instruments—*e.g.*, sponge or forceps. The fact that this accident has occurred with operators of the largest experience should make all careful. It is best met by having a sufficient, definite number to begin with, counting carefully afterwards, and allowing no tearing of sponges (p. 1107).

After-treatment.—I have no space for going carefully into details, but I should like to take this opportunity of saying that critical as the first forty-eight hours undoubtedly are, I believe there is often needless enforcing of rules. Less should be done in the way of frequent catheterism,* the amount of urine being now small, and less routine in the matter of morphia if the patient is not restless or wakeful, and less rigour in enforcing a dorsal position. During the above time little should be given by the mouth save cracked ice, and occasional teaspoonfuls of barley-water or Valentine's meat-juice, with a few drops of brandy is required. Mr. K. Thornton advises the following enemata: About six hours after the operation, or sooner if the patient be very weak, 3 oz. of strong beef-tea, just warm, and without salt, are injected into the rectum. This is to be repeated every three hours (every two if the patient is very weak), and every six hours twenty drops of laudanum

* On the whole I prefer a metal catheter with a single large eye. This can be kept in dilute carbolic acid, and, being shorter than a gum-elastic, there is less danger of its being passed too far and thus causing irritation and most vexatious cystitis.

are added. Before each injection, the female pipe of a Higginson's syringe is placed in the rectum, with the bottom of an ordinary soap-dish under it, so that the flatus and refuse may pass away; it remains in ten minutes, and then the fresh injection is given.

The chief questions that arise are, how best to act in threatening or actual peritonitis. Where only flatulence and some distension are present, they may yield to the passage of a long rectal tube, the injection of an enema containing castor-oil and turpentine, and the use of seidlitz powders and calomel (gr. v) alternately, every few hours. Opening the wound and endeavouring to cleanse the peritoneal sac may be tried (p. 814), but with very little hope. The only sure treatment of peritonitis is the preventive one at the time of the operation.

REMOVAL OF THE UTERINE APPENDAGES.*

Indications.†—Before giving these, I would state that there is no operation in which it is more necessary to consider each case on its own bearings, to explain the object and results with honourable carefulness to the friends and, whenever possible, to the patient herself, and to remember that this is above all one of those operations which should never be entertained if there are any honest doubts as to the patient's health being really impaired beyond the aid of other treatment, and the impossibility of otherwise restoring her to usefulness in the position of life in which she has been placed; and that it is an operation which may concern the happiness of another besides that of the patient. Due weight must be given to the large part played by neuroses in this matter, and to the fact that till we have carefully published cases in which the results have been submitted to the only true test, that of time, we shall not be in a position to decide how far the after-condition of a great number of the patients who have been submitted to this operation, is one of improvement. Finally, it is always to be remembered that it is an operation which has been greatly misused.

The following limited list of the **indications** for removal of the uterine appendages (Hart and Barbour, *Gynecology*, p. 209) will commend itself. (1) *Intoler-*

* This term has been used here for convenience' sake, as more comprehensive than "oophorectomy," &c. Moreover, it is as yet not certain whether removal of the ovaries without the Fallopian tubes will be sufficient to arrest menstruation.

† A paper read some years ago at one of our Medical Societies and the discussion thereon has brought this matter prominently before the profession. I would strongly advise my younger readers to study carefully a very weighty letter in the journals of February 7, 1891, bearing the well-known signatures of Sir John Williams and Dr. Champneys. Every sentence will well repay perusal. I quote a few: "Perimetritis is probably the very commonest of all the serious diseases of women. It is also perfectly certain that the great majority of cases get quite well without any operation. We are far from denying that exceptional cases call for surgical procedures, or that cases of prolonged suppuration in the pelvis are properly treated by the application to them of ordinary surgical principles. But this wholesale resort to a mutilating operation, advocated by several speakers at these discussions, calls for serious consideration by the profession. . . . A plea for patience is to be found in the declaration of the operators that the full benefits of the operation are not felt for months or years after. If the operator would exercise this patience before the operation, there might be less need for its exercise by the patient after the operation."

able dysmenorrhœa—i.e., where the patient has intolerable and prolonged pain every month, wearing her down, rendering habitual recourse to opiates necessary. "But as menstruation is not at first entirely arrested by the removal of the ovaries; and as we have always in such cases pelvic peritonitis adding to the patient's misery, and untouched by the operation, it is evident that we must not expect too much from it." On this point, the words of Mr. Bland Sutton are worthy the careful study of all young operators: "The removal of the ovaries and tubes has been recommended and practised for the relief of such conditions as (1) Epilepsy and insanity; (2) Dysmenorrhœa; (3) Ovarian neuralgia. In this group the procedure has not been followed by encouraging results; indeed, they are so unsatisfactory, that those who have had the greatest experience in this class of surgery are almost unanimous in condemning the operation, save under very exceptional conditions: even then the operator should safeguard himself by seeking confirmatory opinion. The chief objections are summarised in the following clauses: (1) In a very large proportion of cases the removal of the ovaries and tubes fails to relieve the patient. (2) In many cases the operation aggravates the symptoms. (3) Many cases, reported a few weeks or months after the operation, have subsequently relapsed. . . . In many instances where oophorectomy has been carried out for relief of pain, unaccompanied by objective signs in the pelvic viscera, the operators have pointed out, in justification of the interference, that the ovaries were cystic. . . . Such men . . . when they excise an ovary for pain, cut into the organ, and, finding ripe follicles, describe it as a cystic ovary. Every normal ovary is cystic, hence an excuse is readily found." (2) *Bleeding from fibroid tumours, uncontrollable by other means.* It is here that the operation has won some of its most brilliant successes. But Dr. Galabin's warning (*Dis. of Women*, p. 244) must not be forgotten: "Those varieties of fibroids which are liable to continue growing after the menopause—that is to say, soft, non-encapsuled fibroids, and fibro-cystic tumours—are likely also to be unaffected by oophorectomy. (3) *In some cases of hystero-epilepsy, convulsions, and threatened insanity, dependent on ovarian irritation or presence of ovaries with absence of uterus.* (4) *In some cases of ovaries prolapsed or fixed by adhesions, giving rise to intolerable pain in coitus or seriously affecting the patient's health.*

Indications (Dakin*).

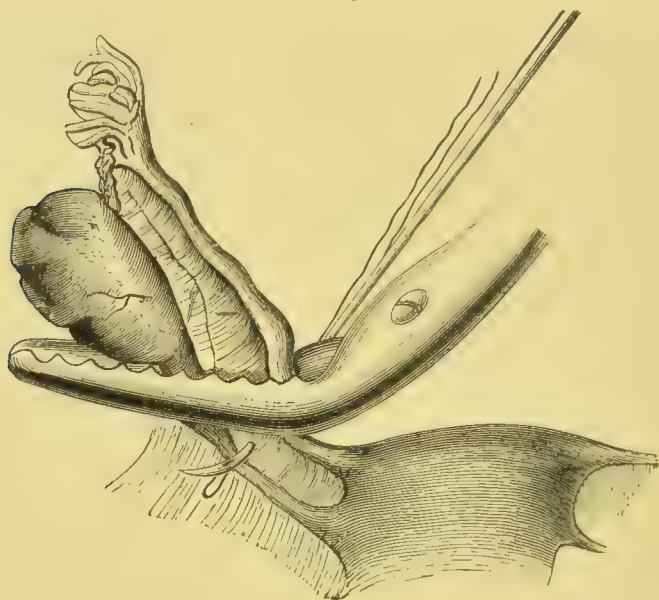
1. *Certain diseases of the appendages themselves.*—The uterine growths necessitating operation are considered below, and tubal gestation is dealt with in another chapter. Those now to be mentioned include only: Collections of pus, whether in the tubes (pyo-salpinx), or implicating the ends of the tubes or the ovaries (perimetric abscesses). The symptoms and signs of pus in the pelvis are not always plain. It is mainly on account of the difficulty of diagnosing its presence that the question of operation by the abdomen in cases where inflammatory diseases of the pelvis are chronic is still in an unsettled state.† In some cases, and unless the operator has had some experience in abdominal surgery, in many, it will be safer (supposing it is decided that an operation is necessary) to seek for a fluctuating spot *per vaginam*, and to open the abscess by Hilton's method than to risk the contamination of the peritonæum with pus from an abscess which bursts during the operation. Parametric abscesses can be opened extra-peritonæally in almost every case, by the abdomen or by the vagina. 2. *Certain cases of myoma of the uterus.*—Oophorectomy for fibroids is, in the hands of most, an unsatisfactory operation, and will, as hysterectomy becomes a less dangerous one

* For the rest of this chapter, and for the next, I am indebted to Dr. Dakin, Obstetric Physician to St. George's Hospital.

† See Cullingworth, "On the Value of Abdominal Section in certain cases of Pelvic Peritonitis, &c. (*Obst. Trans.*, xxxiv, p. 254), and the discussion following.

than it is at present, sink into the background. Still, it has had some brilliant successes, and such an authority as Mr. Thornton is still a firm believer in its value. Its disadvantages in these cases are : that the tumour is not removed ; the result as to cure is uncertain ; the convalescence, including in this the completion of the artificial menopause brought about by it, is often troublesome and protracted. It is not always a simple operation in actual execution, owing to the great anatomical changes brought about by the invasion of the broad ligaments by the myomatous uterus ; it may even be found to be impossible. A case in which it may be considered is : One with a small tumour (the uterus being, say, about the size of a three-months' pregnancy), where there is only one fibroid which is causing symptoms, and this is found to be unfit for treatment by operation through the vagina, and cannot be removed by abdominal section without removing the uterus ; the symptoms—hæmorrhage and menstrual pain—are severe, and do not yield to treatment ; the woman is not over forty, since after this age has been reached the natural menopause may be close

FIG. 312.



The appendages are grasped by large pressure-forceps. The pedicle-needle, bearing a loop of silk, perforates the broad ligament below the forceps and near the uterus. (Doran.)

at hand. It is true, however, that women with fibroids usually undergo the change of life late, and the question of age, from this point of view, is not now considered so important as it formerly was ; and it is also true that some fibroids, mostly those of the soft, non-encapsuled variety, go on growing after the menopause has occurred, and will probably not be influenced by its artificial induction. In the case of large myomata (over the size of a three-months' gestation) it will be nearly always found impossible to make a safe pedicle, owing to the growth of the tumour into the broad ligaments. 3. *In the course of a Caesarian section* (see p 1126). 4. *In osteomalacia*.—In a certain number of cases oophorectomy has been found successful in arresting the progress of the disease. The operation in this connection was suggested by the improvement found to occur where Porro's operation had been performed on women whose pelves had become too distorted by osteomalacia to allow of delivery through them. 5. *The operation must never be done for dysmenorrhœa in the absence of indications under (1), or, possibly under (2).* 6. *It is unjustifiable in cases of hysteria, epilepsy or the like.*

Operation in the case of a small fibroid as under (2), *i.e.*, when the appendages are not inflamed or adherent.

The patient is to be prepared as for ovariectomy, and the stages of the operation are the same until the peritonæal sac has been opened.

It is not necessary to make such a long incision as for ovariectomy since the structures to be removed are much less in bulk, unless, as happens sometimes, the ovaries are found to be evidently cystic. The nearer to the pubes the incision can be carried without risking injury to the bladder the better. A surgeon who has had experience in the removal of ovarian tumours only must remember that the abdominal walls are here not stretched and thinned, and that intestine will probably lie immediately under the incision. The peritonæum must be very carefully divided.

The fingers are to be passed into the abdomen, and, possible changes in the anatomical relations of the uterus being remembered, the fundus is to be found. From this, as a starting-point, the Fallopian tubes will form a guide to the ovaries. The ovary and tube of one side is then drawn gently up to the wound, and caught as shown in the figure (312) by a large elbowed forceps. The ligature is passed by transfixion below this, and secured as directed in ovariectomy. Doran recommends that the mass beyond the large forceps be caught by a smaller pair, and then, as the ligatures are tied, the large forceps can be taken off, allowing the tying to be made tight without danger of the pedicle slipping back into the abdominal cavity before it is certain that it is secure. During the tying the abdominal walls will have to be pressed down so as to avoid tearing the broad ligament by too much dragging on the appendages.

The other side is treated in the same way.

Both pedicles are now to be inspected, the first one being still caught by the small forceps, now to be taken off. The peritonæal sac is sponged out as far as is necessary, and the wound sewn up over a flat sponge as after ovariectomy. In all cases, before removing the appendages of one side, it must be ascertained that those of the opposite side can be got away safely.

Operation when the appendages are inflamed and adherent.

In the words of Mr. Greig Smith: "The operation may be one of the most difficult in surgery. . . . Even in the hands of surgeons of the highest skill, it has not infrequently been abandoned as impracticable. The first difficulty met with is, probably, that the appendages are fixed and cannot be drawn to the surface. They may be represented by an irregular conglomeration of cystic and cicatricial material, and sessile on the broad ligament or in Douglas's pouch, and perhaps intimately adherent to bowels. They are beyond the reach of sight, however much the abdominal walls are depressed. To deal with such a state of affairs one of two courses is open. The first is to enlarge the incision to 3 or 4 inches; to pull the bowels out of the pelvis, and keep them in the abdomen by one or more sponges packed under them; to pull the parietes apart with spatulæ, and seek by a strong light to expose the parts to view, and operate by the aid of light. This may be safe, but it is clumsy and difficult. If the parietes are muscular and firm, considerable force may be required to crowd the bowels into the abdomen, and to keep them there is still more difficult. . . . The other course is that followed by Tait, as a result of his unrivalled experience. Tait has come to the conclusion that it is best to depend entirely on the fingers to deal with such a condition, relying on the skilled sense of touch to guard against the dangers of tearing bowels or other structures. To control bleeding he recommends sponge-packing. First, the fingers map out the actual limits of the diseased organs; then these are gently separated from all surrounding parts, and gradually the mass is unfolded upwards from behind till the only attachment left is the proper pedicle of the parts to be removed. Even as thus separated, the appendages will probably be found sessile on the broad ligament, so that they

can be little more than brought within the range of sight. The broad ligaments are stretched tightly across the pelvis, and dragging on the appendages may tear them. The pedicle ligature may have to be carried under the diseased parts at a considerable depth from the surface. If possible the tissues are gathered together in one pedicle, or by the Staffordshire knot; but the puckering produced may drag upon the opposite ligament so much as to cause tearing. To tie in two parts almost of necessity tears open the tissue between them. It has happened to me in one case, while pulling on a ligature, that the broad ligament was torn clean away from the side of the uterus for a distance of more than an inch. . . .

"The bleeding in these cases is sometimes described as truly alarming, and I have had practical experience of this fact. Sponges are packed in everywhere as the adhesions are separated. If, after the appendages have been removed, bleeding still goes on, a little solution of iodine on a sponge may be applied to the raw surfaces. Of course, visible bleeding points are dealt with by ligature or forcipressure. And it may sometimes be good practice to leave forceps attached to bleeding points for twenty-four hours or so, their handles being left outside. In all such cases the insertion of a drainage-tube for a day or two is advisable.

"If abscesses exist, extra care is necessary to avoid rupture of the abscess-wall. It may be wise, before beginning separation, to aspirate the contents, and place a pressure-forceps on the opening so made. In such cases the placing of sponges all round the diseased parts is peculiarly necessary."

Recently Prof. Martin* of Berlin has advocated a method of removing the appendages, which was introduced by Dührssen in 1894, through the anterior vaginal fornix. This operation has its limits of usefulness, for, although much more room can be obtained by this path than would be expected, it would be unsafe for most operators to deal with inflamed appendages in this way when there was much fixation and many adhesions, and where there was risk of damage to intestines during separation of adhesions to them.

* Martin's operation is described (*Brit. Med. Journ.*, Jan. 4, 1896, p. 10). The full article will be found in the *Monats. f. Geb. u. Gyn.*, Bd. ii. Hft. 2, p. 109; but as the vaginal route scarcely comes into a work like this it is not included here.

CHAPTER XVII.

OPERATIONS ON THE UTERUS.

REMOVAL OF MYOMATOUS UTERI BY ABDOMINAL SECTION.—CANCER OF THE UTERUS.—REMOVAL OF A CANCEROUS UTERUS BY ABDOMINAL SECTION.—REMOVAL OF A CANCEROUS UTERUS PER VAGINAM.—CÆSARIAN SECTION.—PORRO'S OPERATION.—ECTOPIC GESTATION.

REMOVAL OF MYOMATOUS UTERI BY ABDOMINAL SECTION.

Indications.—(1) Large tumours (larger than a three-months' pregnancy) with much hæmorrhage. (2) Large, rapidly growing tumours. The rapid growth suggests some degenerative change, and, in addition, pressure-symptoms may arise suddenly. (3) Tumours causing pressure on vessels or viscera in the pelvis; also in irreducible retroverted uteri large enough to cause bladder-symptoms (retention, dribbling of urine). (4) Signs of degeneration of the tumour, such as rapid growth, pain, softening. (5) Signs of septic changes. (6) Where the operation for removal of the appendages has been begun and found impracticable.

Operation.

An incision is made in the linea alba from the umbilicus downward so as to admit the hand and examine the tumour. If it is decided to proceed, the incision is prolonged upward to the left of the umbilicus sufficiently freely to allow of the tumour being brought out without bruising of the incision or undue force. Any adhesions to the parietes or omentum, intestines or stomach having been dealt with, the growth is lifted forwards by one or two of Tait's screws. This is often rendered very difficult if the lower part of the growth be firmly fixed in the pelvis. As it comes out the surgeon must take care that he is not pulling dangerously on viscera behind to which the growth may still be attached, and which he cannot see.* The relation of the bladder to the tumour must now be carefully made out. If the growth has extended into the pelvis or between the layers of the broad ligament, its connection with the bladder may be very intimate. Thus, the relations of the bladder must be defined, and, if needful, the two must be separated by careful dissection, a step made easier by not emptying the bladder before the operation, and by the passage of a sound.

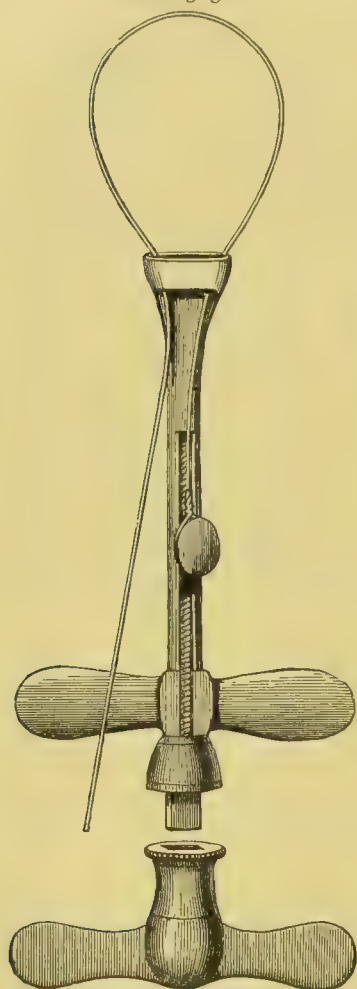
* Mr. K. Thornton (*Dict. of Surg.*, vol. ii. p. 746) points out that much more care is required in securing adhesions now, as a solid tumour allows of far more hæmorrhage than a collapsed ovarian cyst.

There are now three methods of proceeding, and each of them has its special advantages and range of applicability. They are respectively :

- (i) **By wire-constriction.**
- (ii) **By ligature of the uterine and ovarian vessels separately, and subperitonæal management of part of the cervix left behind.**
- (iii) **By complete removal of the uterus.**

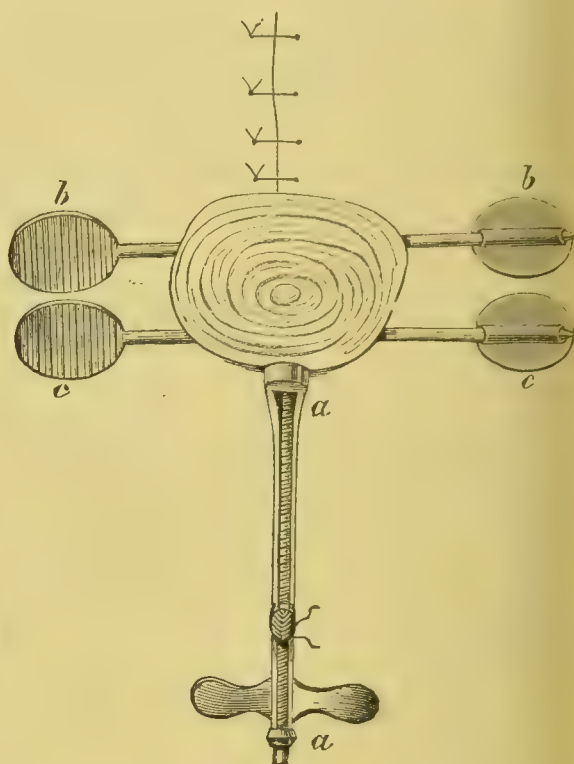
(i) **Wire Constriction.**—This is the form most usually employed. The loop is adjusted either round the narrowest part of the attachment of the tumour,

FIG. 313.



Koeberlé's serre-nœud,
(Galabin.)

FIG. 314.



The lower part of the abdominal wound is shown sutured above the stump. *a, a*, serre-nœud; *b, b*, pin passing nearer the anterior; and *c, c*, pin passing nearer the posterior boundaries of the stump. (Doran.)

or, if it be needful to open the cavity of the uterus, just above the internal os. If it be possible to include the appendages in the loop, this is done : in other cases the broad ligaments must be tied separately after transfixion. When the loop is tightened in position, it is screwed up slowly, for the shrinking of the tissues will allow of further tightening of the wire later on. One or two pedicle-pins are now thrust through the tumour just above the loop, it being intended that the broad and protected ends of these shall, by resting on the abdominal walls, keep the stump up in position. During the above steps, sponges will have been applied so as to stop any fluids from going into the peritonæal sac. Fresh

ones are now carefully packed around, and the growth is cut away sufficiently beyond the pins to allow of paring down a little later. After this has been effected, the wire is finally tightened. The stump thus pared down, painted with iron perchloride or a strong solution of carbolic acid, and dusted with iodoform, is retained *in situ* by the pins and by the first of the sutures closing the abdominal wall, which is put in immediately above the stump.

Any oozing points are now finally looked to, the peritonæal sac cleansed, and the rest of the abdominal wound closed with the precautions given at p. 1112. Dry gauze strips dusted with iodoform—these being distinct from those over the rest of the abdominal wound—are carefully packed around the stump, and the wire is tightened about every two days, fresh strips and the iron perchloride being applied as the stump is clipped away little by little. If the wire has not made its way through in about two weeks, it may usually be removed at this time.

(ii) **Ligature of the Vessels, and Subperitonæal Treatment of the Cervix.**—In this method of operating the body of the uterus is amputated about the level of the internal os, and the ovaries and tubes are cut away. The cut edges of peritonæum forming the stump of the broad ligament on each side are afterwards united over the face of the stump of the cervix.

The vagina is first to be made as aseptic as possible by douching with perchloride of mercury.

The abdomen is to be opened by an incision as described above. The ovarian arteries are then tied by transfixion of the broad ligaments external to the ovaries, and the broad ligaments divided to an extent corresponding to the amount of tissue secured in the ligature. The further securing of the broad ligaments and the uterine arteries depends on the extent to which the enlarged uterus has burrowed between the layers of the ligaments. If these layers are still in fairly close apposition the base of the ligament may be transfixed above and below the artery (recognised by its pulsation) close to the uterus so as to avoid injuring the ureters. If the relations of the parts are so changed by the burrowing of the tumour, the pulsating artery must be felt for between the layers of the ligament and separately under-run with the pedicle-needle and tied close to the cervix. When this has been done on each side, the uterus having been separated from the bladder during the steps above described, the organ may be removed by cutting through it at the level of the internal os. Bleeding points are secured, and the cut edges of the broad ligaments sutured. The stump must have the peritonæal edges accurately united above it so as to prevent septic infection by way of the now opened uterine canal.

(iii) **Complete Hysterectomy.**—In this case the cervix is removed with the body of the uterus.

Operation.—The abdomen having been opened in the usual way, as close down to the symphysis pubis as is safe,* the intestines are drawn out of the pelvis into the abdomen, and, if it be needful to get more room, are brought out and covered with carbolised towels or iodoform gauze tampons kept warm. The uterus is now caught with a powerful vulsellum, and dragged first to one side and then to the other, while the broad ligaments are transfixed by three ligatures which are made to interlock when tied. These are thus described by Mr. Thornton (*loc. supra cit.*): "The first loop passes through the ovarian ligament and edge of the peritonæal covering of the Fallopian tube, and secures the ovarian vessels, the second loop passes through the round ligament and secures the pampiniform plexus. When the first two loops have been tied on each side, the ovaries and tubes are cut away, and the uterus is firmly drawn out of the

* It has been advised to partially detach the recti from their pubic insertion if the abdominal walls are very tense.

pelvis, and a transverse incision is made through the peritonæum between the uterus and bladder; the latter is then peeled back, and the incision carried through into the vagina. The uterus is then held forwards, and the peritonæum divided transversely behind to the same extent as in front, and the vagina opened into through the pouch of Douglas. The uterus is now merely held by small portions of tissue on each side, which contain the uterine arteries, and the third loop of the broad ligament ligatures is passed through on each side into the vagina, or from the vagina by a special curved needle, and tied round the tissues containing the uterine arteries; these small bridges of tissue on each side are then cut through and the uterus removed." The opening into the vagina is not sutured, but lightly plugged with iodoform or other antiseptic gauze. This may be removed per vaginam after forty-eight hours or so.

These three modes of operating have each *advantages* and *disadvantages*.

By that first described, when the stump of the uterus is secured by a serrenœud, the best results have been hitherto obtained, in this country at all events. There is little or no danger of sepsis in skilful hands as long as the stump is carefully looked after, and practically none of hæmorrhage. On the other hand the convalescence is protracted to several weeks owing to the time required for separation of the part beyond the constriction. Also the abdominal cicatrix is not so firm as one resulting from the immediate union obtained in a case where no pedicle has to lie between the edges of the wound.

The convalescence of a successful intra-peritonæal operation is as smooth as that after ovariectomy, and the cicatrix is as sound. There is, however, some danger of septic infection of the peritonæum through the cervix, free communication existing between the vagina and the under surface of the peritonæum united over the face of the stump. The results of such infection have been sought to be minimised by draining the abdominal cavity through the pouch of Douglas into the vagina. Probably a better way is to dissect out the upper part of the mucous membrane of the cervix as exposed from the abdomen, and to accurately suture the raw surfaces thus formed (Mr. Cripps, "Abdominal Hysterectomy, with Intra-peritonæal Treatment of the Stump," *Obst. Trans.*, 1896).

The third method, that of complete removal of the uterus, though no doubt more difficult of performance, is the most satisfactory, since there is no stump left, and there is free drainage of the abdominal cavity. It has been said by some that the pelvic floor is weakened; but Mr. Thornton and other operators by this method are of opinion that no such result occurs.

A myomatous uterus may be removed, if not too large to come through the pelvis and lower genital passages, by the vagina in the same manner as that described for the removal of a cancerous uterus (vaginal hysterectomy). If the uterus is too large to come through entire it may be got away in sections after the vessels of each side have been secured.

CANCER OF THE UTERUS.

Cancer of the Body.—In cases suitable for radical treatment the whole uterus can be removed by an abdominal incision, the operation resembling that for myoma. This method is however very inferior to that of excision by the vagina, since the mortality has been extremely high owing to infection of the general peritoneal cavity with septic or cancerous material during the operation. It has been found also that there is much greater risk of including the ureters by this method than by the vaginal one. This latter operation, to be immediately described, is so successful, and so free from these drawbacks that it is now the one universally adopted.

REMOVAL OF A CANCEROUS UTERUS THROUGH THE ABDOMEN (see the directions on p. 1120 for removal of Myomatous Uterus).

REMOVAL OF A CANCEROUS UTERUS PER VAGINAM. VAGINAL HYSTERECTOMY.

The field of this operation has of late years been much extended. It was formerly employed only in cases where the body of the uterus was affected by the growth, primarily or secondarily to the cervix. Now it is believed by most authorities that total extirpation is a better operation than supra-vaginal amputation of the cervix in cases where the cervix alone is affected. It is believed to be so because the cancer has been occasionally found to have extended to the body before the tissues surrounding the cervix had become involved, and because the operation itself is not more difficult and practically not a more dangerous one.

Contra-indications to Radical Operation.—It is useless to undertake the removal of the whole uterus or of the cervix alone if there is any loss of mobility of the uterus, as this is practically always due to infiltration of the base of the broad ligaments by the cancer. Such infiltration may be felt by the finger which is unaccustomed to estimating small degrees of loss of mobility; and even if no fixation can be felt by the vagina it may be found on rectal examination, a method of exploration of the tissues around the uterus which must be never neglected in doubtful cases, that one or both of the utero-sacral ligaments are involved. An anæsthetic is often of great assistance in such examinations. Unfortunately the large majority of instances which come under the surgeon's notice have already reached a stage at which it is useless to operate.

Preparatory Treatment.—For some days before operation the external genitals are thoroughly cleansed, the vagina washed out with solution of carbolic acid or mercury perchloride, and a plug of iodoform wool inserted. If any very foul granulations are present they may be scraped with a curette and strong carbolic acid may be applied to them. The bowels are also thoroughly cleared out.

Operation.—The patient being in lithotomy position, supported by a Clover's crutch, the uterus is strongly dragged down with a volsellum fixed on the cervix. The parts are dilated for the surgeon by an assistant with a duck-bill speculum held posteriorly. With scissors, the mucous membrane is next cut through circularly, well clear of the disease. In doing this, the relations of the ureters to the cervix must be remembered. Speaking roughly, there may be said to be a distance of three-quarters of an inch all round the cervix within or at which an incision may be safely made. The incision through the mucous membrane should be at least a quarter of an inch away from the surface visibly affected with cancer. The stages of the operation vary according to the practice of different operators. The method which will probably be found the easiest is as follows:

The cervix is to be well pulled forwards and the peritonæum opened in the pouch of Douglas. Through the opening the forefinger is introduced, and the smooth surface of the inner aspect of the peritonæum recognised. The other forefinger is then introduced by the side of the first one, and the opening enlarged towards each side as far as the sacro-uterine ligaments, the resistance of the internal surfaces of which marks on each side the limit to which the opening should extend.

The cervix is now pulled backwards against the posterior vaginal wall, and the bladder separated from the supra-vaginal cervix. This is best done with the fingers, care being taken as the tissues are torn through not to wound the bladder. This is best ensured by keeping the tips of the fingers in close contact with the uterus. After separating the two organs for about an inch or so, the utero-vesical fold of peritonæum will be reached, and the peritonæum will be found at this level to be more firmly adherent to the uterus posteriorly and to the bladder anteriorly. It is now best to pass a forefinger through the opening into the pouch of Douglas, over the upper edge of the broad ligament of one side, and down on to the upper surface of the corresponding utero-vesical fold, for then this fold of peritonæum can be perforated with certainty. Perforation is easily accomplished by pushing the point of a Spencer Wells' forceps through it from the vagina on to the finger. This opening is enlarged by the two forefingers in the same way as that into Douglas's pouch. The uterus is now attached to the pelvic wall by the broad ligaments alone.

These ligaments contain the vessels supplying the uterus, two on each side—the uterine set, which run in the base of the ligament, just a little deeper than the incision which has been made through the mucous membrane of the vagina, and the ovarian set, running at about the level of the ovary.

The forefinger of the left hand being passed into the anterior peritoneal opening, a ligature of strong silk is carried through the base of the ligament on one side by a pedicle-needle with a fairly sharp curve which transfixes the bridge of tissue at about an inch above the level of the vaginal fornix. This ligature is firmly tied, and the opposite side treated in the same way. The uterine artery on each side should now have been secured. The tissue between the ligature and the uterus is now cut through with scissors as high up as the ligature extends. The uterus can now be dragged a good deal farther down into the vagina, and the remainder of the broad ligament on each side ligatured and divided in stages from below upwards, the last ligature passing over the upper edge of the ligament. As each portion of ligament is ligatured and divided the uterus becomes more and more free, and is by the last cut separated from the body, and can be removed.

No sutures should be introduced, but the vagina lightly plugged with antiseptic gauze. By refraining from suturing the peritoneal or mucous edges of the gap left by the removal of the uterus, free drainage of the peritoneal cavity is procured, and this free drainage is no doubt the cause of the very low mortality of this operation.

Instead of ligatures, some operators prefer to leave pressure-forceps attached to the stumps of the broad ligaments, removing them in forty-eight hours or so. This makes the operation shorter, and is perhaps safer for the time: but hæmorrhage has been known to occur on the removal of the forceps, and ligature is probably safer in the long run.

The operation may in some cases be made easier by pulling the fundus of the uterus through the anterior or posterior opening in the peritonæum, thus turning the organ upside down and bringing the upper edge of the ligament within easy reach. But this involves the risk of infection of the peritonæum up above by the cancerous and septic cervix.

CÆSARIAN SECTION.

Indications.

(1) When the pelvis is too small to allow the passage of the child by the natural passages, even after embryotomy has been performed. The mother may be delivered in this way (2) when she wishes to have a living child, and when the

proper time for the induction of premature labour has gone by, or (3) the pelvis is too small to allow a viable child to pass by being born prematurely. For more exact indications under these headings the reader is referred to works on midwifery. The abdomen and uterus may be opened after the death of a pregnant woman if the child is of viable age and may reasonably be believed to be alive at the moment of the mother's death.

Time of Operating.—It is unnecessary to wait until labour has begun, and it is very inconvenient to have to do so. The uterus contracts just as well whether labour has begun or not, and if it is considered desirable to ensure some dilatation of the cervix to allow of the escape of the lochia, a bougie or a tent may be inserted into the uterus the night before the operation. The fact that the time can be fixed beforehand, and all the instruments and assistants prepared for a given hour, is an important element in the success of the operation.

Operation.—The patient should be prepared as for ovariectomy, and the instruments required are the same as for that operation; except that no trocar nor pedicle-needle will be needed, and eight or ten half curved needles, and a large, flattened Hodge's pessary, sterilised, should be added. There should be two assistants, in addition to the anæsthetist. The position of the child should be made out as accurately as possible, so that the head or knee may be at once grasped when the uterus has been opened.

The abdominal incision is made in the middle line, and its height on the abdomen depends on whether the woman has a pendulous belly or not. It must be six inches long, and not nearer than three inches to the top of the pubes. When the uterus has been exposed, its middle line should be brought under the incision.

The pessary is now to be laid on the uterus opposite the centre of the abdominal incision, and firmly pressed on the wall by the first assistant. This will check the bleeding from the sinuses in the uterine wall, and the muscle can be deliberately cut through, layer by layer, till the membranes are reached. The latter will probably bulge through the wound. If the placenta be in the line of incision it will doubtless bleed, but the bleeding can be arrested by plugging the wound with the forefinger of the left hand. This finger is now to be run along between the membranes and the uterine wall, and used as a director on which to divide the latter, the incision is thus carried up and down for about three inches each way. It can be made with a blunt-pointed pair of scissors or a probe-pointed bistoury. If the placenta lies in the line of the incision, the finger is passed between it and its amnionic covering, and it is cut through along with the muscle.

The membranes are now to be ruptured, and the hand at once passed in and the child extracted by its head or by a knee. If this is (*a*) not done pretty rapidly, or if (*b*) much liquor amnii has been allowed to escape, or if (*c*) the incision in the uterus has not been made long enough, the child may be gripped round the neck by the rapid contraction of the opening. The first assistant must keep his hands firmly pressed on the abdominal surface, just outside the abdominal incision, to prevent fluid finding its way into the peritoneal sac, until the uterine incision is completed. He can then hook a finger into each commissure of the uterine incision and hold it firmly against the under surface of the abdominal wall. The cord is at once clamped and divided, and the child handed over to the second assistant, who sees to its respiration.

The placenta and membranes are now to be completely removed. The assistant next passes a flat sponge behind the uterus, which is in its reduced bulk easily squeezed out of the abdominal wound. It should at once be folded in a soft cloth wrung out in an antiseptic solution at 110° Fah.

The assistant grasps the uterus in such a way that the forefinger and thumb of each hand form an ellipse enclosing the uterine wound, and he thus controls all bleeding from the cut edges, which will lie with their divided surfaces in one plane.

The sutures are now inserted. They should consist of silk, of about the thickness used for tying an ovarian pedicle of average bulk. They should be passed at intervals of half an inch. The needle should include the outer two-thirds only of the thickness of the uterine wall, so as to ensure that the inner surface and decidua layer are not reached; if the sutures entered the uterine cavity they would afford a ready channel, for a time at all events, by which the peritoneum might become infected by the lochia. When the lips have been brought accurately together by the sutures—and accuracy is of the utmost importance—most operators add another series of sutures including the peritoneum alone, and passed in the same way as the Czerny-Lembert suture in the case of the intestines. This can be made of catgut, and used as a continuous suture.

The uterus is now to be carefully sponged, and then it may be squeezed firmly in another warm towel, so as to ensure its firm contraction and retraction. It is then returned to the abdomen.

It is a very essential part of the operation that the woman should be sterilised so as to prevent the necessity for a repetition of the same operation at a future date. This is best done before the uterus is returned to the abdomen by ligaturing a loop of the Fallopian tubes and cutting the loop off.

The abdomen is then closed in the usual way.

PORRO'S OPERATION.

This modification of the Cæsarian section may be employed (1) when the uterus is exhausted and will not contract; or if it is believed to be septic; (2) in cases of malacosteon pelvis, since removal of the ovaries has been found to have a curative effect on the disease; (3) when the surgeon does not feel certain of being able to manage the complete suturing of the uterus, which is essential in the ordinary form of the operation.

The steps are the same as in the ordinary operation till the child has been removed. It is unnecessary to extract the placenta. The loop of a *serre-nœud* is passed round the uterine body just above the cervix, and the uterus treated as in hysterectomy (p. 1121).

ECTOPIC GESTATION.

Indications.—It is now accepted as a universal rule that an ectopic gestation should be operated upon as soon as possible after it is diagnosed. No attempts to kill the ovum *in situ* should be made.

It will happen that the ovum may be at one of several stages in the progress of this abnormal kind of pregnancy.

A. It may be diagnosed or strongly suspected, but direct signs of a living child have not yet appeared. The case will be one of not later than the fourth month. The gestation may thus be:

1. *Tubal and unruptured.*
2. *Ruptured into the abdomen, whether tubal or intra-ligamentous.*
3. *Intra-ligamentous, not having undergone secondary rupture, and growing.*

(1) *Tubal and unruptured.*—This class will include cases up to the age of two and

two-and-a-half months. The operation is then identical with that of oophorectomy ; or, if there are many adhesions, to that for a diseased tube. Care should be taken not to rupture the sac in bringing it up to the wound for ligature.

(2) *Ruptured into the abdomen, whether tubal or intra-ligamentous.*—It is at this stage that surgical interference will be oftenest called for. On symptoms of severe abdominal hæmorrhage the abdomen should be opened in the middle line, and the blood which will probably be filling it disregarded. The object is to secure the bleeding vessels at once, and the cleansing of the peritoneal sac can be afterwards attended to.

The fundus uteri is to be identified, and the tubes traced outwards from this. The affected tube is then to be brought up to the wound, and a large Spencer Wells' forceps adjusted to secure the part of the broad ligament which contains the vessels and lies internal to and beneath the sac. A ligature can then be applied at once, or the abdomen can be first flushed with warm water now that the bleeding has been arrested by the forceps.

If the sac is intra-ligamentous, the broad ligament internal to and beneath the sac should be secured as well as possible with forceps, and the sac rapidly shelled out from between the layers of the broad ligament if this can be done. The remaining cavity had better be plugged with iodoform gauze, all visible bleeding points having been first secured. Its edges should be first secured to those of the abdominal wound or, if it is more convenient, it may be drained through the vagina, and the abdomen completely closed. It has occasionally been possible to transfix the sac, stitch it up, and obliterate its cavity.

(3) *Unruptured intra-ligamentous, growing.*—The part of the broad ligament enclosing the ovum is to be cut through at a place, if this can be chosen, devoid of large vessels, and the ovum shelled out as in the last case. It might possibly be necessary to remove the uterus if the placenta is seated on its side.

B. *There may be direct signs of a living child.*—Cases in this class may be at any age from the fourth month to term.

Or (C) *there may be the physical signs and history (possibly) of a recently or remotely dead child.*

The same rules hold good as to operating as soon as possible. In the case of a living child the great difficulty is the treatment of the placenta. This organ and its site are certain to bleed very freely at the operation if any detachment occurs ; and if the placenta is left behind in the sac there is the greatest possible risk of septic absorption.

If the incision in the abdominal wall can be made so as to avoid this organ, whose position may be sometimes recognised by palpation (never by auscultation, and this must be remembered, since many authors wrongly state that the situation of the placenta can be ascertained by means of the uterine bruit) so much the better. The best place to choose is where the foetal outlines can be most plainly felt. The sac should be opened extra-peritoneally if possible. The child is extracted, and a clamp put on the cord, which is divided on the maternal side of the clip. If there is any possibility of completely removing the sac this should be carefully considered, as by such a procedure much of the difficulty afterwards is removed. It is, however, scarcely ever possible to remove it, and the sac must be stitched to the edges of the abdominal wound. The blood should be allowed to escape as completely as possible from the placenta through the divided vessels of the cord, and if the placenta cannot be safely stripped off the sac-wall it must be left behind, and the cord should be cut short off. A large drainage-tube is used for the sac, and the opening is closed round the tube. Or an attempt may be made to dry up the placenta by freely applying some such powder as benzoate of soda, or a mixture of tannic and salicylic acids. If this is done the sac must be plugged with strips of gauze, instead of being drained by a tube. The opening

must be carefully watched and not allowed to close, and no accumulation of fluid is to be permitted. The placenta may come away in shreds. In case of any septic absorption that seems at all dangerous the sac must be re-opened and an attempt made to remove the placenta at all risks.

If the child has been dead for some weeks at the time of operation, and the circulation through the placenta has dwindled considerably, it may not be difficult to remove the placenta without much bloodshed, and this should always be attempted; if it cannot be done the case must be treated in the way just described.

CHAPTER XVIII.

SACRO-ILIAC DISEASE.

ARTHRECTOMY. — ERASION.

It has lately been shown that the prognosis in this disease, usually looked upon as so grave, is much better if the same radical methods of treatment, which have proved so satisfactory in other joints, are applied to the sacro-iliac synchondrosis.

Mr. Collier first drew attention to the above fact with a case successfully treated by trephining (*Lancet*, 1889, vol. ii. p. 787), and Mr. Makins and Mr. Golding Bird followed, each surgeon publishing three successful cases (*Clin. Soc. Trans.*, vol. xxvi. p. 127, and vol. xxviii. p. 186). The following points are taken from these papers :

Operation.—The joint is exposed by a crucial incision (Makins), or by a flap (Collier, Golding Bird). In the words of the last-named surgeon, “a semi-circular flap of skin and subcutaneous tissue over the iliac area of the joint, and having its convexity corresponding to the posterior edge of the ilium is dissected upwards and forwards, and the underlying glutæi are detached. The bone being thus freely exposed, a large trephine is applied at the root of the posterior inferior iliac spine, and in a line drawn from the top of that spine to the junction of the anterior with the middle third of the iliac crest. . . . The ilium at the seat of operation is very thick, but the disc of bone removed should reach quite down to the joint.” The trephine-opening is then sufficiently enlarged, the articular surfaces cut away with an osteotome sufficiently to enable the surgeon to explore the pelvic abscess of the joint, and to liberate any pus lying on this aspect. The sharp spoon, or Barker’s flushing gouge (p. 1152) is thoroughly used, all fragments of bone or loosened cartilage removed, and any sinuses present laid open. Iodoform emulsion having been next applied, the soft parts are lightly drawn together with a few sutures. A long outside, or a Thomas’ hip-splint, should be used at first, but subsequently, all that is needed, is a well-fitting pelvic belt, as advised by Mr. Hilton.

PART V.

OPERATIONS ON THE LOWER EXTREMITY.

CHAPTER I.

OPERATIONS ON THE HIP-JOINT.

AMPUTATION AT THE HIP-JOINT.—EXCISION OF THE HIP-JOINT.

AMPUTATION AT THE HIP-JOINT (Figs. 315-323).

THIS formidable operation has been much simplified of late years by the most important improvement of Mr. Furneaux Jordan,* whose method should replace all others in every possible case. It will be described first here, and a few of the other methods, sufficient for all practical purposes, will be given afterwards.

* Dr. W. E. Arnold, assistant-surgeon U.S. Navy, has kindly drawn my attention to the fact that an amputation, in all essentials the same as Furneaux Jordan's, was performed as long ago as 1806 by Dr. W. Brashear in Bardstown, Kentucky. The following account taken from a letter by Dr. Brashear will be found in Dr. Mott's edition of Velpeau's Surgery, in a summary of hip-joint amputations by Dr. Eve, of Tennessee. The patient was a lad, aged seventeen. An operation on the thigh in the ordinary manner was determined upon, as remote from the hip-joint as circumstances might justify (in this case, about mid-thigh). The amputation was performed and the arteries secured. The great step was to make an incision to and from the lower end of the bone externally over the great trochanter, to the head of the bone and upper part of the socket. The dissection of the bone from the surrounding muscles was simple and safe, by keeping the edge of the knife resting against it. The bone being disengaged from its integuments at its lower extremity, was then turned out at a right angle from the body, so as to give every facility in the operation to separate the capsular ligament and remove the head from its socket. The patient made a good recovery. Judging from a letter from Prof. Ollier to Mr. Shuter (*loc. infra cit.*) the former surgeon had recommended this method in 1859, and performed such an operation once.

Methods.—I. Furneaux Jordan. II. Antero-posterior Flaps. III. Lateral Flaps. IV. Modified Lateral—viz., Antero-internal and Postero-external—Flaps.

I. **Furneaux Jordan's Method** (Fig. 316).—By amputating through the thigh as low down as possible, and shelling out and disarticulating the femur, it is now possible to avoid, in large measure, those dangers which were formerly inseparable from the operation—viz.: 1. Shock, the limb being removed much farther from the trunk. 2. Hæmorrhage. *a.* Abundant room is afforded for compression of the common femoral, and the vessels behind. *b.* The large vessels can easily be secured on the face of the stump. *c.* The gluteal and sciatic arteries remain untouched, the hæmorrhage from these, in the older operations, being a source of serious danger. 3. Septic changes. By the other methods, the copious discharge of bloody serum from the large wound,* being poured out close to the anus and genitals, was very liable to decompose. By this operation, both the end of the stump and the wound on the outer side can be more easily drained and kept aseptic. In making use of this amputation, especially for hip disease or failed excision, the surgeon should not attempt too much to secure primary union.† 4. The stump is a better one. It is longer, more mobile, and occasionally, as in amputation for acute periostitis or necrosis, it is possible to preserve much of the periosteum from the upper half of the femur, and a cord‡ will be left which will

* As will be shown below, the wound in a Furneaux Jordan amputation is also a large one, but much more happily placed for being drained and kept sweet.

† Verneuil (*Paris Acad. de Méd.*, 1877).

‡ The committee of the Clinical Society appointed to examine Mr. Shuter's case of sub-periosteal amputation of the hip-joint reported (*Trans.*, vol. xvi. p. 89), (1) that, though there was a firm, resisting cord of considerable size in the centre, which afforded the muscles a common point of attachment, there was not sufficient evidence to enable them to state that this cord contained bone; (2) that the muscles were in a high state of nutrition, the patient not only powerfully flexing, extending, abducting, and adducting his stump, but being able to communicate all these movements to the artificial limb.

Mr. Shuter in his paper (*loc. supra cit.*) says that his patient was able to wear an artificial limb "for some hours nearly every day for a period of about five months. I then forbade his wearing it for a time on account of a tender sinus which opened opposite to the acetabulum. In the notes of this case, quoted by Mr. Holden in his obituary notice of Mr. Shuter (*St. Barthol. Hosp. Reports*, vol. xix. p. 38), it is stated that "the stump was sufficient to enable the patient to wear an artificial limb for a time, but he was obliged to leave it off on account of its weight." I have now performed this amputation seven times. Six recovered, and, in one of my three cases in adults, a delicate girl of twenty has been able to wear a very light limb, made by Messrs. Maw and Thompson, for three hours at a time. In such cases as these, where the patient is much reduced by long-standing hip disease, and the periosteum is still adherent to the wasted femur, it is not, in my opinion, advisable to spend time in stripping it off. While the shock of the hip-joint amputation is much lessened by this method, it cannot, of course, be entirely removed.

render the stump movable. Whether in any case an artificial limb can be worn for more than about half an hour at a time is very doubtful.

Methods of Controlling Hæmorrhage during Amputation at the Hip.

1. *Elastic Compression by Jordan Lloyd's Method* (Fig. 316).—This may be applied at the junction of the limb and trunk, without interfering with the operator, by the following method: When the patient is passing under the anæsthetic, the limb is emptied of blood by elevation and application of Esmarch's bandages as far up as the tissues are healthy; the patient is then rolled over on to his sound side, and a piece of rubber bandage about 2 yards long, and stout enough to require decided exertion to stretch it out fully, is doubled and passed between the thigh and trunk, its centre lying between the anus and tuber ischii. A white bandage of appropriate size is then laid over the termination of the external iliac artery. The ends of the rubber bandage are now to be firmly and steadily drawn in a direction upwards and outwards, one in front of the groin and one over the buttock, to a point above the centre of the iliac crest, sufficient tightness being employed to stop all pulsation in the femorals or tibials. The front part of the band passing over the white bandage occludes the external iliac and runs parallel to and above Poupart's ligament. The posterior part runs across the great sacro-sciatic notch and controls the branches of the internal iliac. If the surgeon is short-handed, instead of the cords being held by an assistant, they may, by means of tapes strongly stitched to them, be thus secured: having been drawn with full tightness up to the centre of the iliac crest, they may be crossed over to the opposite side and tied firmly (over lint) midway between the crest and the top of the great trochanter. If a strong and trusty assistant is forthcoming, it will be better to leave the bandage in his hands, but in the case of an adult whose tissues are not wasted, and on a hot day, the exertion is not a slight one.*

Whether the bandage be held or tied, especial care must be taken that it does not slip from off the external iliac nor over the tuber ischii. It is a good plan to pass the ends of the india-rubber band over a slip of wood, so as to diminish the prolonged pressure on the hands. To prevent the bands slipping down in the way of the surgeon, two loops of tape or bandage may be thus employed: each, about 2 feet in length, is placed longitudinally. before the elastic band is applied, the one over the groin, the other well behind the great trochanter, the centre of each being where the elastic band will go. When the band has been applied, these

* As will be seen from the description of the operation below, this exertion is only required during shelling out of the femur, a step often simplified by a previous excision. During the circular amputation in the lower third of the thigh, and the securing the large vessels here, there is abundant room to control these by an Esmarch's bandage applied in the usual way.

form loops by means of which the band is kept well out of the operator's way, both at Poupert's ligament and behind the great trochanter (Jordan Lloyd, *Lancet*, 1883, vol. i. p. 897).

2. *Davy's Lever* (Fig. 315).—This ingenious instrument, introduced by Mr. Davy, of the Westminster Hospital, consists of a smoothly turned rod of ebony-wood or metal, from 18 to 22 inches long, with the rectal end enlarged, bluntly conical and most carefully polished and graduated, and the other forming the handle.

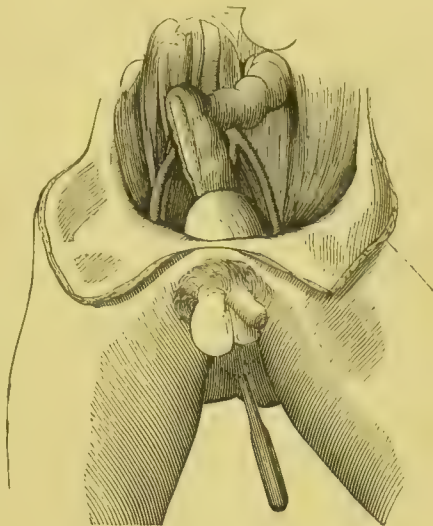
Oil having been thrown into the bowel, the rectal end is introduced, directed towards the vessel to be compressed, and felt for over the situation of the artery through the abdominal wall. Thus, if the right external or common iliac is to be compressed, the handle is lowered and carried over close to the adductors on the left side, so that its end drops over the artery on the pelvic brim (Fig. 315).

Mr. Davy (*Brit. Med. Journ.*, 1879, vol. ii. p. 685) claims for his instrument the following *advantages*:—(a) More perfect control of both external and internal iliacs. (b) It inflicts a minimum amount of disturbance on the respiratory movements and the circulatory system. (c) It is generally and easily applicable. A

strictured rectum is the sole obstacle. [So also would be a short and tight meso-rectum.] (d) The pressure applied is easily maintained, while the assistant in charge of the lever is out of the way of the operator. (e) Its application is quite safe in skilled hands, no injury having ever resulted, and but little pain having been suffered. (f) It is cheap and simple. (g) It has been successful. Mr. Davy, in his paper above quoted, had records of ten cases in which the lever had been employed; the total amount of blood lost during the ten operations had been under 18 oz., and there had been 80 per cent. of recoveries. *Disadvantages*.—Simple and ingenious as the above method is, it is beyond doubt that it has caused a fatal result from injury to the peritonæal coat of the rectum. It is now likely to be replaced by the Furneaux Jordan method. On account of the above risk I prefer to meet the hæmorrhage either by the above-mentioned method, or, where this is impossible, by securing the vessels before they are cut (p. 1140).

3. *Compressing the common femoral or the termination of the external iliac* by the fingers or hands, aided, if need be, by a weight. This is only possible in the case of a child, and the assistant thus employed is liable to be in the way of the operator. 4. *Lister's tourniquet*.—This means of compressing the termination of the abdominal aorta is not a light matter, apart from the very grave operation into which it enters. This is owing to the difficulty of making sure of avoiding such important structures as the duodenum, pancreas, solar plexus, and small intestines, and to its interference with respiration and circulation. The bowels must be thoroughly emptied beforehand, and got out of the way by gently rolling the patient on to his right side before the pad is applied. In the *American Text-book of Surgery*, p. 1193, two useful hints are given, one to apply a soft sponge between the pad and the skin, and the other, to lose not a moment in putting catch forceps on the chief bleeding points after the main vessels have been tied, so that the tourniquet may be promptly loosened.

FIG. 315.



(After Davy.)

(5) *Macewen's Method of Compression of the Abdominal Aorta.*—*Ann. of Surg.*, 1894, vol. i. p. 1. Prof. Macewen has used the following for over fifteen years and found it simple, always ready, and easily applied and efficient. Amongst the cases in which it has been used were disarticulations at the hip-joint, amputations in the upper third of the femur, large pelvic vascular tumours, intra-pelvic hæmorrhage, and traumatic hæmorrhage from the external iliacs; in all the control of the circulation was absolute. No injury has followed to the small intestines. If the patient vomits or coughs violently, the pressure must be temporarily increased. As the patient lies on his back on the table, the assistant, facing the patient's feet, stands on a stool at the left side of the table in a line with the umbilicus. He then places his closed right hand upon the abdomen, a little to the left of the middle line, the knuckles of the index finger first touching the upper border of the umbilicus so that the whole shut hand will embrace about 3 inches of the aorta above its bifurcation. The assistant then standing upon his left foot, his right foot crossing his left, leans upon his right hand, and thereby exercises the necessary amount of pressure. With the index finger resting upon the common femoral at the brim of the pelvis, the assistant can easily estimate the weight necessary for the purpose. In this way an efficient assistant can control the circulation for half an hour without fatigue.

(6) *Compression of the common iliac through an abdominal incision.* (Dr. C. McBurney, *Ann. of Surg.*, August, 1894, p. 181).

(7) Commanding the main artery during the operation either by seizing a flap (Figs. 318, 319) or by securing the vessels before they are divided (p. 1140).

(8) *Wyeth's bloodless method of amputation at the hip-joint.*—I have mentioned this in the account of amputation at the shoulder-joint at p. 120. It has been largely used by American surgeons, and has given excellent results. It shares, with the methods of Davy and Tylden Browne's special clamp (*Ann. of Surg.*, February, 1856, p. 153), the objection of needing a special apparatus which will not be always at hand. Further, the pins must be passed with exactness, and unless of sufficient strength will certainly bend under the strain of the cord above. Its use is thus described (*New York Med. Journ.*, 1890, vol. i. p. 529; *Med. News*, 1893): two mattress needles, each 10 inches long and $\frac{3}{8}$ ths of an inch in diameter, and strong white rubber tubing $\frac{1}{2}$ inch in diameter are needed. The limb is first elevated and an Esmarch's bandage applied from the toes to the trunk. The first needle is introduced * 1 inch below and a little internal to the anterior superior spine passing through muscles and deep fascia external to the neck and emerging on a level with the great trochanter 3 inches from point of entrance. The second needle enters at a point internal to the saphenous opening and 1 inch below the level of the crotch: passing through the adductors it emerges 1 inch below the tuber ischii. Corks are then placed on the points to protect the surgeon. The tubing is now wound round five or six times above the needles and tied very tightly. The Esmarch's bandage is now removed and a circular incision is made 6 inches below the tourniquet joined by a longitudinal incision

* Dr. Wyeth now applies the tubing rather higher. Thus the outer pin is so inserted that the tubing lies in the notch just below the anterior superior spine. In this way the pressure is entirely above the level of the joint.

commencing at the tourniquet and passing over the trochanter major. A cuff including the subcutaneous tissue down to the deep fascia is dissected off to the level of the trochanter minor. About this level the remaining soft parts are divided down to the bone with a circular cut and are rapidly dissected from the femur. The vessels should now be searched for and both arteries and veins tied with good-sized catgut. The muscular attachments are separated so that the capsular ligament may be exposed and divided. The limb being used as a lever the thigh is forcibly elevated, abducted and adducted letting in air and rupturing the ligamentum teres. The tourniquet may now be carefully loosened and all bleeding points at once seized. In cases of great exhaustion Dr. Wyeth would do the operation in two stages, securing the vessels, dividing the femur below the lesser trochanter, closing the wound and turning out the head of the femur about two weeks later. While the 633 cases of amputation at the hip-joint collected by Ashurst showed a mortality of 64.1 per cent., of 42 cases performed in this manner only nine died—a mortality of 21.4.

The above statistics are very good, but I believe that the Furneaux Jordan Method if carefully carried out, will give as good results without the need of relying on any especial instruments which may not be at hand just when required. In support of this I may say that I have had seven cases and only lost one. I am very strongly of opinion that two methods of arresting hæmorrhage here will be found sufficient for all cases. 1. Furneaux Jordan's amputation aided by the Jordan Lloyd's Method of compression (p. 1132). This will suffice for all cases of hip disease which form the great majority of cases calling for amputation here. (2) In the much smaller class of accident or growths by using Prof. Macewen's Method (p. 1133) and by securing the vessels before they are cut (p. 1140), the flaps being made according to the need of the case. In every case of amputation at the hip-joint shock and loss of blood should be prevented by an assistant injecting a hot solution of sodium chloride (p. 86) while the amputation is being performed.

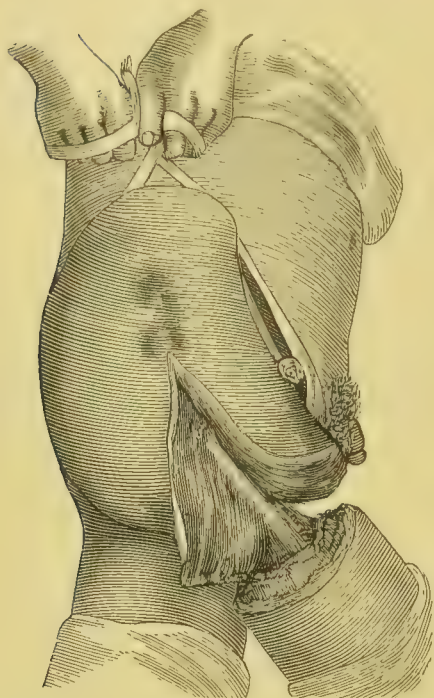
Furneaux Jordan's Operation * (Fig. 316).—The vessels in front and behind having been commanded in the manner given at p. 1132,† the patient's pelvis is brought to the edge of the table and the body rolled a little on to the sound side, the surgeon standing

* Every provision must be taken against shock. The limbs should be bandaged in cotton-wool, the body well wrapped up on a hot-water table, the head kept low, ether given, nutrient injections kept at hand, and subcutaneous injections of brandy or ether given from time to time. As stated at p. 86, saline infusion should be resorted to early (R. J. Pye-Smith).

† Before commencing the circular amputation, a little above the knee, I have the limb elevated, an Esmarch bandage applied up to the knee, the thigh emptied of venous blood by firm stroking, and a second Esmarch bandage then applied firmly just below the trochanters, and the lower one removed. The india-rubber band is also (p. 1132) placed, lightly, ready *in situ*. The circular amputation is then performed, and the large vessels secured. The upper Esmarch is next removed, and the india-rubber band firmly tightened while the femur is shelled out or, perhaps, disarticulated.

usually to the right of the diseased limb—*i.e.*, inside on the left and outside on the right side—draws up the soft parts forcibly with his left hand, and makes a circular incision through the lower third of the thigh, using his knife as at p. 1173, the assistant who is in charge of the limb rotating it so as to make the tissues meet the knife. A circular cuff-like flap of skin and fasciæ is then

FIG. 316.



Furneaux Jordan's amputation. Above is shown the means of controlling hæmorrhage described at p. 1132. Lower down are seen the sinuses of an unhealed excision, and the method of shelling out of the femur, after a circular amputation has been performed, and the large vessels secured.

quickly raised for about $2\frac{1}{2}$ inches,* an assistant, who stands opposite the surgeon, giving much help here, by seizing and everting the cut edge of the flap, as the surgeon raises it. The flap being drawn upwards out of the way, the soft parts are severed by one or two vigorous circular sweeps down to the bone, and the large vessels and any others that can be seen are next secured. Pressure† is now made with sterilised sponges on the still oozing wound, and the patient being now rolled well over on to his sound side the surgeon cuts along the outer side of the thigh, starting from the circular wound and ending about midway between the iliac crest and top of the great trochanter. This incision goes straight down to the bone and runs into any excision wound, or sinuses which may exist over the joint. The soft parts are then rapidly stripped off the femur,

partly with the knife, partly with the finger, the only difficulty met with being along the linea aspera. If an excision has been performed, the operation is rapidly completed, but if the head and neck remain intact, the final steps will be rendered more difficult, and the joint must be opened from the outside by cutting strongly on the neck of the bone, this being facilitated by the assistant moving the limb in accordance with the surgeon's directions, as different parts require to be put on the stretch, rotation of the

* The surgeon need not trouble to raise a larger circular flap. As the femur is removed, the muscles lose their fixed point to contract from, and are thus easily covered.

† Valuable time should not be wasted in trying to secure every bleeding-point either now or later. See foot-note, p. 1137.

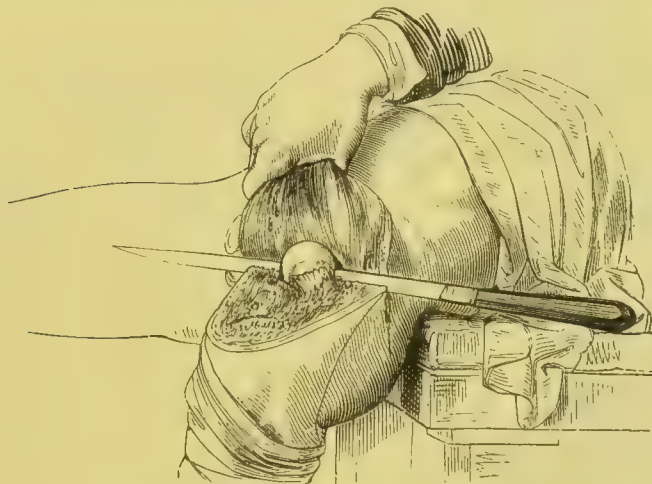
femur strongly outwards, and dragging of the head away from the acetabulum being required at the last.

Free drainage must be provided, for it must be remembered that the wound left by this method is a very large one, though it has the advantage of being farther removed from sources of sepsis. Thus, especially if the tissues are riddled with sinuses, too much of the wound must not be closed, and, if shock is present,* the surgeon must not wait to insert many sutures, but, trusting to firm bandages over an aseptic dressing, get his patient quickly back to bed. If disease of the acetabulum be present, the surgeon will, if the patient's condition admit of it, attend to this, the use of a sharp spoon (Fig. 326) and the insertion of a drainage-tube through this bone being specially required if pelvic suppuration be present.

Amputation by Different Flap Methods.—The following will be given here, it being understood that in no case can any of them be recommended if Furneaux Jordan's method is available:

II. Antero-posterior Flaps (Figs. 317-320). **Methods of Guthrie and Liston.**—The patient having been prepared against shock (p. 1135), and the

FIG. 317.



(Fergusson.) †

main vessels secured by one of the methods already given, the limb being brought over the table and supported in the semi-flexed position by an assistant, while the opposite limb is secured over the table by a bandage, the surgeon standing outside the left and inside the right limb, raises the tissues in front of Scarpa's triangle with his left hand, enters his knife (*e.g.*, on the left side) midway between the anterior superior spine and the top of the great trochanter, and sends it across the limb so that it emerges close to the tuberosity of the ischium.

* In some cases this is so from the beginning of the operation. This was most markedly the case in one of the patients mentioned in the foot-note, p. 1131, a very delicate young lady of twenty-two. It was only by not waiting to do more than secure the femoral, making firm sponge-pressure on the flaps, tilting up the end of the table so as to keep the head low, inserting no sutures, but trusting only to firm bandaging over dry gauze dressings, that a fatal result was averted.

† The knife represented here is needlessly long.

In traversing the limb the knife should pass as close to the capsule as possible, so as—(1) to get behind the large vessels; and (2) to facilitate the opening of the

FIG. 318.

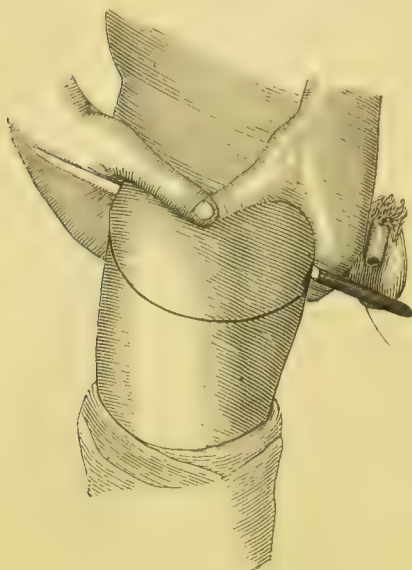
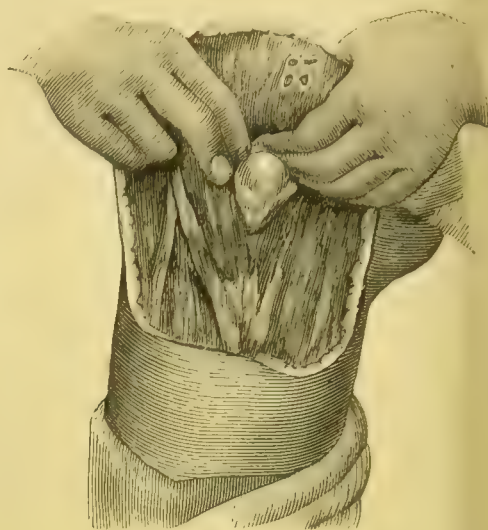
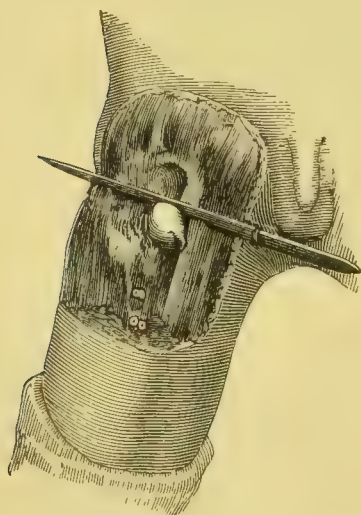


FIG. 319.



capsule later on. As the knife emerges, the surgeon will, of course, be careful of the scrotum and the opposite thigh, and at this moment the point should be well depressed, so as to include all the tissues possible in the anterior flap. With a rapid, sawing movement a broad flap is cut, 5 inches long, an assistant thrusting

FIG. 320.



his fingers into the wound as it is made, and following the back of the knife, to secure the large vessels (Figs. 318, 319). As he then draws up the anterior flap, the capsule is exposed, covered with more or less of soft parts, according to the skill with which the knife has been first inserted; the assistant in charge of the limb at this moment extending, depressing, and rotating out the femur, so as to put the capsule on the stretch, the surgeon forcibly draws the knife across the capsule, opens it freely, and divides the ligamentum teres (Fig. 320).

The limb being now slightly flexed, adducted, and pulled away from the body, the surgeon severs the parts attached to the great trochanter and the outer aspect of the limb, and passing his knife behind the bone, cuts a posterior flap about 4 inches long. The assistant in charge of the limb will facilitate this step, and further the dislocation of the femur, if he bring the

thigh upwards and forwards with one hand placed at the back. A large sponge wrung out of 1 in 20 carbolic acid, is at once pressed against the posterior flap while the femoral vessels* are secured, or, if these are well in hand, those in the hinder flap are taken first. The glutæal will be found in the glutæal muscles.

* Of these the femoral lies superficially, the profunda more deeply, in the anterior flap: they are shown much too close to each other in Fig. 319.

the sciatic with the nerve nearer the posterior margin of the flap, and the circum-flex and obturator closer to the acetabulum.

If the patient's condition admits of it, any sinuses are now laid open or scraped out, the acetabulum examined, and, if perforated, drained. If the amputation has been for growth, any outlying masses are looked for and removed. Any nerves or muscles which need it are now trimmed short, a large drainage-tube inserted, and the flaps carefully united.*

Advantages of this method. Chief of these is its rapidity. — *Disadvantages.*

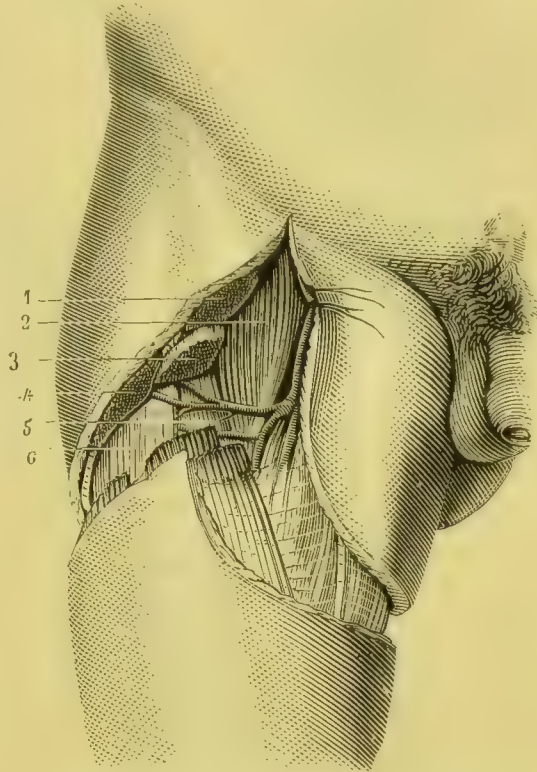
1. The hæmorrhage which takes place from the vessels from the posterior flap may be considerable.
2. The large amount of sero-sanguineous oozing which takes place from so many large muscles cut obliquely.
3. The fact that, in an adult, it requires a special, long knife, not always found in an ordinary collection of instruments.

— *Difficulties.* 1. Not passing the knife deeply enough, and thus not exposing the capsule. 2. Passing the knife too deeply, and hitching its point on the bone. 3. Getting the knife stopped in passing it behind the head of the femur. 4. Fracture of the femur.

Guthrie's Method by Antero-posterior Flaps.—Antero-posterior flaps are again made use of, but here they are made from without inwards, and thus can easily be rendered less bulky. A small knife — *i.e.*, one 4 inches long—suffices.

The preparatory steps being taken as before, the surgeon, standing on the right side of either limb, marks out his anterior flap, about 5 inches long, by an incision, starting (on the left limb) from just above the great trochanter, passing across the thigh with a broadly curved convexity, and ending just below the tuber ischii. A posterior flap is then marked out by carrying the knife in a similar manner across the back of the limb between the same points, the limb being raised and the surgeon stooping somewhat. This flap should be about two-thirds the length of the first. Both consist of skin and fasciæ. The flaps being held out of the way, the muscles, first on the front and then on the back, are next cut obliquely from below upwards, the femoral vessels, both superficial and

FIG. 321.



Amputation at the hip-joint by modified lateral flaps (anterior racquet-shaped incision). 1. The sartorius. 2. The ilio-psoas. 3. The rectus. 4. The tensor vaginæ femoris. These have been cut and retractors have exposed (5 and 6) the internal and external vasti. A double ligature has been placed upon the common femoral vessels. (Farabeuf.)

* If grave shock is present, the head should be lowered and sutures put in, any oozing being stopped by firm spica-bandaging, and Spencer Wells' forceps left *in situ*. The lower end of the bed should be kept raised, and brandy given subcutaneously and per rectum. Transfusion should also be employed early (p. 86).

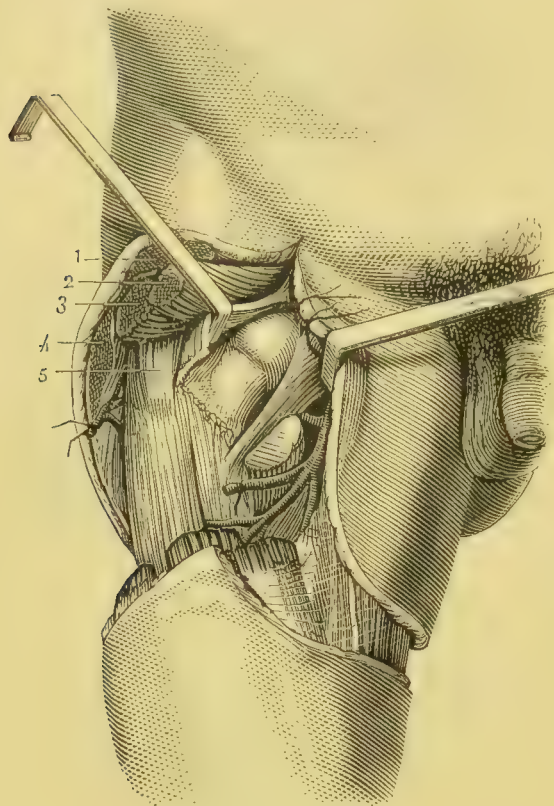
deep, being secured as soon as they are exposed, and before they are cut, either by underrunning them with an aneurism-needle loaded with silk, or by dividing them between two pairs of forceps. The capsule being exposed, disarticulation is performed as before.

III. Lateral Flaps.—The methods of Larry and Lisfranc need not be more than alluded to here. In both, the flaps were cut by transfixion, and were about 4 inches long. Larry tied the common

femoral as a preliminary step. Flaps made by either method are so bulky as not to be recommended.

If the surgeon wishes to use lateral flaps, as in a case involved by growth in front, he may make them, thus, from without inwards. Standing on the right side of either limb, he, *e.g.*, in the case of the right limb, marks out an inner flap by means of an incision starting from below the tuber ischii, carried downwards along the inner aspect of the thigh for about 4 inches and then curving upwards to the centre of the groin and ending, a little below Poupart's ligament, to the outer side of the femoral vessels; next, without taking off his knife, he then marks out an outer flap by cutting between the same points, but in the reversed direction. This incision, as it passes downwards, outwards, and backwards, should leave the front of the limb about

FIG. 322.



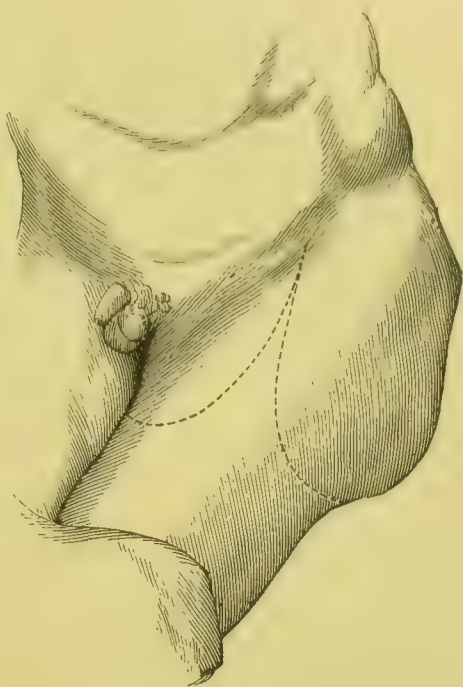
The same operation as in the last figure, in a more advanced stage. The capsule has been opened and its outer lip drawn aside by a retractor. The other retractor draws inwards and protects the vessels. 1. Sartorius. 2. Psoas. 3. Rectus. 4. Tensor vaginæ femoris. 5. Attachment of glutæus minimus. (Farabeuf.)

a hand's-breadth below the great trochanter. The flaps having been dissected up, the soft parts are cut through from without inwards, the femoral vessels being secured before they are cut, and disarticulation performed last.

IV. Antero-internal and Postero-external Flaps (Figs. 321, 322, 323).—This is a modification of the last method, and may be useful in cases of growth extending high up, where it is impossible to perform a Furneaux Jordan's amputation. Some such flaps as the above may be the only one obtainable. They may be made as follows: The precautions as to shock given at p. 1135 having been taken, the patient's pelvis having been brought well down to the

edge of the table, and the opposite limb being held aside, but not tied, the surgeon, standing to the right of either limb, reaches somewhat over and marks out (in the case of the right limb) an antero-internal flap, but cutting from a point close to the tuber ischii to one a little below and internal to the anterior superior iliac spine. The skin and fasciæ having been dissected up, the muscles are cut through till the femoral vessels are reached and secured. Large carbolized sponges are now pressed into this wound, and, the patient having been rolled a little over, a postero-external flap is marked out and dissected up from the glutæal region, passing between the above points, but in the reverse order. The glutæal vessels are next cut through, the chief vessels being secured by Spencer Wells' forceps; the capsule is then opened, the round ligament severed, and the limb removed.

FIG. 323.



EXCISION OF THE HIP.

Indications.—A. Disease. B. Injury, especially gunshot.

A. Disease.—The value of excision here has been much disputed. The chief questions are: Does it save life? Does it shorten treatment? Is the limb a better one?

To take two of the chief writers on hip disease and the subject of excision, Mr. Howard Marsh,* with his experience gained from Ormond Street and the Alexandra Hospital for Hip Disease in Childhood, and Mr. G. A. Wright,† of Manchester and the Pendlebury Hospital for Sick Children. Mr. Marsh is strongly against excision, for these reasons. He considers the results obtained by continued rest to be such as to render excision totally uncalled for. Thus, continued rest gives a mortality of only 5 per cent., 70 per cent. of the cases thus treated recovering with only slight lameness and loss of movement. Even when suppuration has occurred, the mortality is only 6 or 8 per cent. Again, at p. 309, Mr. Marsh writes: "The estimate that I have been led to form is, (a) that, in the early stage of the disease, although matter is developed, the operation is as unjustifiable as it is to remove a testis, an eye, or a

* *Diseases of the Joints*, p. 317.

† *Hip Disease in Childhood*, p. 93.

tooth for incipient but still curable disease; (b) that the operation is generally uncalled for, even when sinuses have formed; (c) that if hip disease has been allowed to reach the stage in which the bones have become extensively carious, in which matter has burrowed widely, and in which the general health has become seriously affected, excision will be of very doubtful benefit. The operation will be fatal in at least 10 per cent. of the cases, while in another 20 or 25 per cent. it will be followed by no improvement in the patient's condition."

On the other hand, my old friend, G. A. Wright, speaking from the very large experience of over a hundred cases of excision, of which only three, at most, died of the direct results of the operation, strongly urges that the hip should be excised "as soon as there is any evidence of external abscess . . . and still better results would, I believe, be obtained by operating before the pus has escaped from the articulation. The operation is discredited because it is put off until disease is so far advanced that no treatment can have more than a fraction of good results, while timely excision cuts short the disease, saves pain, lessens the time of treatment, and gives a better limb." And again, at p. 97 of his book, Mr. Wright says: "While fully aware that abscesses disappear and tuberculous lesions cicatrise under favourable circumstances, I think that, in the case of the hip, delay is unwise amongst the hospital class, with whom it is as yet impossible to deal on the same lines as with the well-to-do. In almost every instance I have found much more extensive disease than might be expected from the external evidence, unless the pathology of the affection is borne in mind, and I believe that, once this chronic osteomyelitis is established, nothing short of excision can, *in hospital cases*, prevent the ultimate progress of the disease to abscess, and too often to gradual exhaustion of the patient by pain and discharge. Nature, of course, in many cases will, unaided, get rid of the dead bone by slow and tedious processes, but the number of children who can survive the process of elimination is very small, while the mortality after early excision is not great, and the failures are mainly in those instances where the operation has been put off till too late. Where actual necrosis, or caries of the head of the femur, with destruction of bone and cartilage, and often sequestra of varying size in the acetabulum, or at least caries of it are known to exist, I think few advocates of non-operative treatment will be found." With reference to so wide a divergence of opinion between two authorities on the subject, it may be pointed out that Mr. H. Marsh worked under conditions more favourable than those which fall to the lot of most hospital surgeons. Thus, at the Alexandra Hospital, cases are kept under treatment as long as rest and extension are required; if an operation is called for, the case is transferred elsewhere. While every one must admire Mr. Marsh's success, it is clear that the conditions under which it has been gained must, as yet, stand alone.

Increasing experience of the improved results obtainable by the anterior excision (p. 1150), has led surgeons to resort to excision of the hip more frequently of late years.

My own opinion as to the advisability of excision in the ordinary hip disease of hospital children is, that it should be resorted to (1) when suppuration is present, and has resisted a fair trial of rest, and antiseptic incision and drainage, this latter step giving an opportunity, though a limited one, of investigating the amount of disease present; (2) when there is much thickening about the great trochanter; and (3) when there is much pain, especially at night, not yielding to a due trial of rest. But while I should thus advocate the performance of the operation in the second stage, I think that sufficient importance has not been attached to the fact that disease of this most important joint is, unless not only seen but treated in the first stage, severe and progressive, and, *per se*, likely to end fatally; if this be so, excision must not be too much reproached with failure. The depth of the joint, the needful interference with soft parts, the difficulty of keeping the wound aseptic in children, the kind of patient, and the tubercular origin of the disease, must always be remembered. For these reasons I cannot quite agree with G. A. Wright (*Dis. of Child.*, p. 558), "that excision," as soon as suppuration and other evidence of necrosis is present, "should be looked on as an ordinary operation for necrosis, and the operation itself is not necessarily attended by a higher mortality than sequestrotomy elsewhere.

The following are the conditions given by the Clinical Society's Committee on excision of the hip-joint as calling for excision—viz. :

i. "Necrosis, and separation of the entire head of the femur, and its conversion into a loose sequestrum."*

ii. "The presence of firm sequestra either in the head or neck of the femur, or in the acetabulum." This question is a most important one, for as Mr. Marsh (p. 318) writes, "much difference of opinion exists as to the frequency with which hard sequestra of any material size are present in suppurative hip disease." He himself thinks that when present sequestra usually consist of porous, friable bone. Their structure is such that, should excision not be performed, they will crumble away and disappear, and will not prevent repair.† A distinctly different opinion is held by Mr. Wright (*loc. supra cit.*, p. 118): "here opening of abscesses, and, still less, expectant treatment, can hardly be considered a satisfactory mode of getting rid of sequestra, yet in no less than in 39 (out of 100) were there actual loose sequestra, while in many others there were patches of bone which

* Mr. Marsh (*loc. supra cit.*, Fig. 50, p. 383) thinks that these cases are not rare. Mr. Hilton (*Rest and Pain*, Fig. 63, p. 341) shows a similar specimen. I should have thought the condition a very uncommon one.

† "This seems to be proved by the fact that in numerous cases in which profuse suppuration has been going on, so that there can be no reasonable doubt that extensive bone disease has been present, all the sinuses will close, although either no bone has worked out or been extracted. In these instances we must conclude either that no sequestra were present, and in that case it would appear that sequestra are not so common as some believe; or that they often crumble away and are discharged, so that operative interference is by no means essential for their removal" (Marsh, *loc. supra cit.*, p. 319).

was practically dead though not loose. The possibility of removing sequestra without a formal excision is worth trying in some cases, but it is often impossible to discover the presence of the sequestra until the end of the bone has been removed, or to extract them if found. Moreover, even after the removal of sequestra, others may exist and not be found, and in other instances the disease progresses in the surrounding bone and necessitates subsequent excision. There are often, too, other foci of disease in the medulla, which are as great bars to recovery as the sequestra themselves."

iii. "Extensive caries of the femur, or the pelvis, leading to prolonged suppuration and the formation of sinuses."

iv. "Intra-pelvic abscess following disease of the acetabulum."

With reference to these conclusions, I should doubt myself whether excision can be often justifiable, especially in the latter. Even if it gave the desired drainage the patient's condition with disease of the acetabulum is not one usually to give the required repair after excision. "Extensive caries" of the pelvis certainly, and in many cases of the femur, will require amputation, especially after childhood.

v. "Extensive and old-standing synovial disease and ulceration of the articular cartilages, with persistent suppuration." This condition is rarely seen in the hip-joint, where the disease, as usually met with, starts not in the synovial membrane, as in the knee-joint, but as a chronic osteo-myelitis in the neighbourhood of the epiphyses, especially the upper one.

vi. "Displacement of the head of the femur on the dorsum ilii, with chronic sinuses and deformity."

This condition will probably be more rarely met with nowadays, as earlier facilities for treating hip disease arise. I happen to have performed excision seven times for such cases; of these six recovered with sound and useful limbs, but in one, a lad of eighteen, in which the sinuses had closed some years before the operation, I should now prefer to improve the condition of the limb by a Gant's osteotomy and division of the contracted sartorius, tensor vaginae, and adductor longus. These patients seem to me to bear excision well, this being probably due to their having good vitality, as shown by their survival, and the amount of repair. Further, in running successfully the gauntlet of the disease, they have escaped the dangers of lardaceous and general tubercular trouble. The surgeon here must, if he excise, be prepared for a good deal of trouble in dislodging the displaced head, after sawing through its neck, owing to its being firmly matted down by old adhesions.

The Condition of the Limb. Is this a better one after Excision or after a Cure by Rest?

Here, again, there is marked divergence of opinion, Mr. Marsh (*loc. supra cit.*, p. 308) is of opinion that "the limb after excision of either the hip or the knee is usually very inferior to the average limb that is obtained after recovery has followed the treatment by rest." Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 757, 1883) thinks that, while recovery after excision of the hip-joint is very complete as far as the movements of the limb are concerned, "the shortening is generally greater than after the spontaneous cure, and the limb is less firm, and on the average, less useful." The Clinical Society's Committee reported on this subject that, after excision, "movement is more frequently present, and is also more extensive, but that patients often walk more insecurely and with a considerable limp, while the limb after treatment by rest and extension, though frequently more or less fixed, is more firm and useful for the

purposes of progression. While feeling assured that the resulting usefulness in *some* cases treated by excision far surpasses the best results obtained by rest, I consider that the *average* result obtained by rest is superior to that following excision, and that this is increasingly marked after childhood, the limb, especially in adolescents recovering after excision, being very often flail-like and useless.*

On the other hand, Mr. Wright, whose large experience on this subject has already been referred to, has come to the conclusion (*loc. supra cit.*, p. 126) that "excision gives a better limb than the average result obtained without operation;" and again (p. 114): "In my own experience, useless, flail-like joints are exceedingly rare, and limited to those cases where the excision was performed in very late stages of the disease; the powerless condition is, I take it, the result of the disease, not of the operation." With regard to the two conditions which chiefly interfere with the usefulness of the limb after hip-excision—viz., a flail-like state, and shortening—Mr. Wright's opinion on the former has already been given. With regard to the latter, he considers (p. 108), that "though some shortening must necessarily result, this arises mainly from the weight being borne upon the limb prematurely. . . . Growth in length of the femur takes place almost entirely at its lower epiphysial line, hence the loss of length or true shortening is only the distance from the line of section of the top of the head, coupled with such arrest of growth as may result from impaired nutrition, this last being, of course, a very inconstant quantity."†

Conditions of Success in Excision of the Hip.—Amongst these are: 1. Age. I consider the best six to fourteen. After eighteen excision should rarely be performed, Furneaux Jordan's amputation taking its place. Mr. Wright (p. 126) thinks that after fifteen excision should be rejected in favour of amputation. 2. Absence of lardaceous disease. I cannot agree with the conclusion of the Clinical Society's Committee (*loc. supra cit.*, p. 233), that excision is called for, "when, in a case of suppuration, enlargement of the liver and albuminuria, indicating the presence of degeneration of the viscera, is detected." Excision should be performed, in my opinion, only before the appearance of lardaceous disease. When there is evidence of this condition having set in especially in the kidneys or intestine, amputation is only to be preferred. 3. Absence of advancing mischief in other joints, or of tubercular lesions in the viscera—*e.g.*, the lung. 4. The disease must be

* Prof. Bruns of Tübingen (*loc. infra cit.*) is of opinion that in the preservation of function the balance is greatly in favour of the conservative treatment as opposed to resection.

† On this matter Mr. Wright quotes Prof. Ollier's (*Rev. de Chir.*, 1881; *Annals of Surgery*, January 1886) estimate that, up to five years of age, the growth of the femur takes place about equally at its two ends; that, after five, the rate of growth of the lower end increases rapidly till it becomes three times that of the upper.

removed as entirely as possible. Thus, in the femur at least, the section must pass below all foci of disease. All sinuses should also be scraped out. 5. Adequate drainage. 6. Careful after-treatment, the wound being kept aseptic. 7. The patient must not be kept too long on his back in hospital air.

B. Gunshot Injuries.

Excision of the Hip-joint for Gunshot Injuries, contrasted with Conservative Treatment, and Amputation at the Hip-joint.

—For the sake of convenience it will be well to take the above three plans of treatment of gunshot injuries of the hip together. As before, I shall avail myself of the laborious researches and the unrivalled authority on this subject of Dr. Otis. He writes (*Med. and Surg. Hist. of the War of the Rebellion*, pt. iii. p. 165) that the evidence collected during the American war shows that “of the cases of undoubted intra-capsular shot-fracture of the hip treated by conservation, 98.8 per cent. had a fatal termination, that in sixty-six cases treated by excision, the fatality was 90.9 per cent., and that in sixty-six cases treated by exarticulation, it was 83.3 per cent.; but from these results it should not be concluded that operative interference was always indicated, and that amputation was preferable to excision. On p. 121 of *Circular No. 2*, I have already pointed out that the question as to the most eligible treatment of shot injuries of the hip-joint is not susceptible of a purely arithmetical solution, and that the variety of the conditions under which the patients are placed, the diversity in the extent of their injuries, and the inevitable imperfection of all surgical records, forbid any such rigorous comparison. No less than nine of the sixty-six cases of excision were complicated with such lesions of the pelvic walls and viscera as made any operative interference useless; among the sixty-six coxo-femoral amputations, probably all successful cases have been recorded, while some fatal cases may remain unpublished, and in the 304 cases treated by conservation, the correctness of the diagnosis may be questioned in many instances. The character of the injury must determine the choice of treatment; but the general rules regarding shot wounds of the hip-joint laid down in *Circular 2* are uncontroverted: that expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the articulation can be clearly established,” that “primary excisions of the head or upper extremity of the femur should be performed in all uncomplicated cases of shot fracture of the head or neck;” that “intermediary excisions are indicated in similar cases where the diagnosis is not made out till late;” that “secondary excisions are demanded by caries of the head of the femur or secondary involvement of the joint;” that amputation should be performed—“1. When the thigh is torn off, or the upper extremity of the femur comminuted with great laceration of the soft parts, in such proximity to the trunk that amputation in continuity is impracticable. 2. When a fracture of the head, neck, or trochanters of the femur is complicated with a wound of the femoral vessels. 3. When a gunshot fracture involving the hip-joint is complicated by a severe compound fracture of the limb lower down, or by a wound of the knee-joint.”

It is possible that Dr. Otis's opinion as to the uselessness of expectant treatment in gunshot injuries of the hip-joint will need alteration in the future—i.e., Prof. Langenbeck,* from his experience in the Franco-German war, considered that the expectant treatment gave a larger proportion of recoveries than excision, and still more than amputation, and advised that the expectant method should always be resorted to save when disarticulation is rendered inevitable by the

* *Arch. f. Klin. Chir.*, 1874, Bd. xvi. S. 309-316. The recoveries seem to have been twenty-five out of eighty-eight cases so treated.

destruction and shattering of the limb. Sir T. Longmore (*System of Surgery*, vol. i. p. 561), thinks that this question must be held to be still "*sub judice*, and surgeons must wait for still more extended experience. under modern improved methods of treatment, before any rule can be accepted as having yet been established on this grave question."

Examining into the dates at which the excisions of the hip were performed, Dr. Otis (*loc. supra cit.*, p. 126) gives the mortality rate as 93 per cent. for the primary, 96.6 per cent. for the intermediary, and 63.4 per cent. for the secondary operations. Thus, "the excisions and amputations practised during the intermediary or inflammatory stage are by far the most dangerous, and should never be performed except as compulsory operations."

As to the dates of the exarticulations of the 254 cases, there were 82 primary, with 75 deaths (91.4 per cent. mortality); 55 intermediary, with 52 deaths (94.5 per cent.); 40 secondary, with 33 deaths (82.5 per cent.); re-amputations, with 4 deaths (36.3 per cent.). Dr. Otis shows from these statistics that "intermediary operations offer the least chance of recovery, that the results of primary operations are more favourable; that secondary exarticulations give one recovery in twelve cases; and that of the instances of re-amputation one in about three proves successful. . . . Unless the nature of the injury is such that the operation can be delayed till the secondary period, it is better that it should be done at once, although it would appear that the dire results of amputations at the hip performed during the Schleswig-Holstein war of 1864, the Austro-Prussian war of 1866, and the Franco-Prussian war of 1870-71, have had a tendency to raise doubts regarding the expediency of, especially the primary, exarticulation of the hip."

Operation.—Two will be described here: A. By posterior incision; B. By anterior incision.

A. Posterior Incision (Figs. 324, 325).—The chief advantage of this is its better drainage, a point which is of less importance nowadays, and which no longer outweighs, in my opinion, the smaller interference with muscles entailed by the incision in front (p. 1150).

While the patient is being brought under ether, a stirrup is applied if weight-extension is to be made.* The child being rolled over on to his sound side, and the parts thoroughly cleansed, the surgeon stands usually outside the limb, the patient's body being in either case placed conveniently at the edge of the table, one assistant supporting the limb, while another is opposite to the surgeon. An incision, about $3\frac{1}{2}$ inches long,† is now made over the middle‡ of the great trochanter, commencing about midway between the top of this bone and the anterior superior spine, and ending over the shaft, just below the trochanter. The incision should curve slightly forwards and pass down to bone or cartilage, as the case may be, at once. Any bleeding vessels having been secured, the exact position of the head and neck is now made out by an aseptic finger, aided by an assistant rotating the limb. A second

* There is no occasion to apply an Esmarch's bandage above the wound; and rendering the limb evascular, save by elevation, is often rendered impossible by the presence of an abscess or sinuses.

† This is usually sufficient in a child. But it must be always remembered that a small wound, by giving insufficient room, leads to bruising and difficulty.

‡ The advantage of going as far forward as this is, that the fleshy and vascular parts of the muscles attached to the great trochanter are better avoided.

incision opens the capsule freely. With a periosteal elevator, aided by a knife, the muscles attached to the great trochanter are detached, the cartilage in young subjects peeling off with them in one or more pieces. The finger is now passed round the neck of the femur and the soft parts, including the periosteum,

FIG. 324.



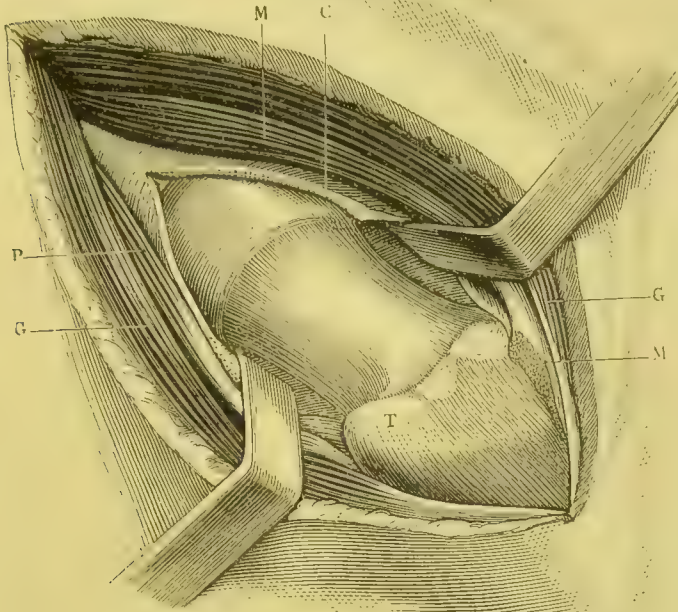
Resection of the head of the femur by the posterior incision. The thigh is flexed to an angle of 45° . The glutæus maximus has been divided, allowing the great trochanter to come into view. The retractor draws aside the skin, the upper part of the glutæus maximus, and the medius. Below it is the pyriformis. (Farabeuf.)

detached as much as possible on the inner side. The finger, now feeling that the upper part of the trochanter and the neck of the bone are free, and protecting the soft parts on the inner side, the bone is sawn through just below the top of the trochanter with an osteotomy, metacarpal, or keyhole saw.* This division should be

* The section of the bone should always be made while this is *in situ*. The plan of dislocating the head by adducting the limb, and then sawing it off, disturbs the parts more, and runs the risk of fracturing the wasted femur of a little child, an accident which I have seen occur in the hands of a very careful operator. Mr. Wright (*loc. supra cit.*, p. 101) states that he had one case among his earlier operations, and that he has also separated the lower epiphysis in an infant while manipulating the femur during incision of the joint. He points out another objection—viz., the ease with which the periosteum may be stripped off if the head of the bone is thrust out.

thoroughly and cleanly effected without splintering. If it be preferred, in addition to the protection of the finger on the inner side, a blunt dissector may be passed behind the bone as well, but this is not essential: retraction will protect the lips of the wound from the saw. With the aid of the finger and an elevator, or with a lion-forceps, the head and neck of the bone are levered out of the acetabulum, this being often attended with some difficulty

FIG. 325.



Excision of the head of the right femur. Separation of the capsule and periosteum has been thoroughly performed. G. Glutæus maximus. M. Medius. C. The capsule opened. P. Pyramidalis. T. Great trochanter. The upper retractor raises the upper lip of the glutæus maximus, the medius, the minimus which is hidden, and the capsule. The lower retractor depresses the pyramidalis and the capsule. (Farabeuf.)

unless the capsule has been very freely opened. The ligamentum teres is probably destroyed; if not, it must be divided. The acetabulum is then examined, and, if merely roughened, left alone; if pitting or erosion are present, gouging must be resorted to.*

Any bleeding-points are now looked to,† and drainage provided

* Any sequestra present must be removed. If the acetabulum is perforated, and pus present on its pelvic aspect, free exit must be provided by means of a gouge or small trephine, and a drainage-tube passed through.

† The hæmorrhage is usually very slight. Firm plugging around the drainage-tube with strips of iodoform gauze will arrest troublesome oozing, and is preferable to spending time in trying to secure vessels, unless these spring distinctly.

to the very bottom of the acetabulum. No sutures should be inserted.

Site of Section of the Femur.—Having tried both, I think that the section through the great trochanter (*i.e.*, just below its upper margin) is preferable to one above it (*i.e.*, through the neck). The latter has the *advantages* of disturbing and damaging the attachments of muscles much less, and thus leads to more rapid healing and far greater mobility of the limb. These, however, are outweighed by the *disadvantage* which leaving such a large piece of bone as the trochanter entails—*viz.*, that, after healing, this process gets drawn up against the scar and constantly frets it.* It is also said to check the escape of discharges, and to render the patient liable to persistence or recurrence of the disease. I am doubtful as to the last two, but the first is absolutely certain.

B. Mr. A. E. Barker,† has shown what excellent results the **anterior method** can give. In his Hunterian Lectures (*Brit. Med. Journ.*, 1888, vol. i. p. 1326) he advocated the use of this mode of excision in the early stage of hip disease. In later papers (*ibid.*, 1888, vol. ii. p. 1337, and 1890, vol. ii. p. 1009) he published some most successful cases thus treated in later stages, where other means had failed, and abscesses were threatening to burst. He advocates the anterior incision on the following grounds especially, (1) the interference with the muscles is practically *nil*; (2) the patient can thus be treated and his wound dressed much more conveniently—*e.g.*, with a Thomas's splint; (3) primary union can be secured if the following most essential points are strictly attended to; (*a*) the whole of the diseased structures must be removed; (*b*) perfect asepsis must be secured; (*c*) all oozing must be checked, and the wound kept dry by well-applied dressings; (*d*) absolute rest must be maintained during healing. With regard to the objection which has usually been considered to be fatal to the anterior incision, *viz.*, the insufficient drainage which it gives—Mr. Barker replies that the incision, though anterior, is perfectly adequate for drainage, (1) because the discharges are, if the above-given precautions are duly followed, very small in quantity, "little more than odourless serum, which ought never to become truly purulent;" (2) "if

* About ten years ago I made use of this method in one case, sawing the bone through the neck and leaving the trochanter entire. A rapid recovery took place, and the boy quickly recovered power over the limb. He has long been able to run and climb like other lads, and the movements of flexion, extension, abduction, and adduction are extraordinarily perfect. He has, however, been under my care on several occasions for superficial ulceration of the scar, which is fretted by the very prominent upper margin of the immediately subjacent trochanter.

† Mr. R. W. Parker (*Clin. Soc. Trans.*, vol. viii. p. 108) recommended this method as interfering less with the muscles and the blood supply of the joint. Hüter was, I believe, really the first to use this incision, draining the joint by a counter-puncture at the back.

all the tubercular tissue is removed, a clean walled cavity is left, most of which is quite capable of healing by first intention, when its different surfaces are brought into close contact by firm pressure. And, in these cases, the head of the bone being removed and the acetabulum quite clean, the cut surface of the neck of the femur can be brought close up to the latter, so that although there is potentially a large space in the field of operation, there ought to be actually little or no cavity left, if pressure have been properly applied from the first."

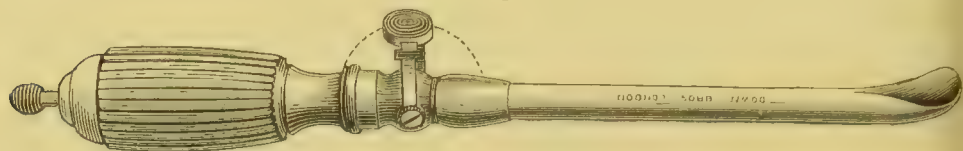
Of the conditions which it is absolutely necessary to secure for the obtaining of primary union, and the success of the anterior incision, the first—that the whole of the diseased structures must be removed—is by far the most important. It is also from my experience the most difficult to secure. G. A. Wright (*Brit. Med. Journ.*, 1888, vol. ii. p. 1338), speaking at the discussion on one of Mr. Barker's papers, said that he had found the entire removal of the morbid tissues practically impossible either by the anterior incision which he used occasionally, or by the posterior. Only little foci of disease might be left, but they were apt to suppurate when some fall or accident gave them the opportunity. On this point we must wait for the light which further carefully watched and reported cases alone can give us.

Operation.—The patient being on his back, with the limb extended, and the parts duly cleansed, the surgeon standing, in the case of either limb, on the right side, makes an incision 3 to 4 inches long, starting $\frac{1}{2}$ inch below the anterior superior spine downwards, and slightly inwards, between the tensor vaginæ and glutæi externally and the sartorius and rectus internally. The upper part of this incision should pass down to the capsule at once, the lower third should divide skin only. A second incision in the upper part of the first should certainly open the capsule. An aseptic finger now examines the condition of the joint. The wound being opened by retractors, a narrow-bladed saw is introduced in the upper part, in the direction of the wound, *in situ*, and, with as little damage to the soft parts as possible, the femur is sawn through across the top of the great trochanter, or through the neck.

The advantages and disadvantages of the latter step have been already given at p. 1150. In a case at all advanced there will always be a risk that a section as high up as this will expose diseased bone. The head of the femur is now extracted and the acetabulum treated by the means given at p. 1149. Every atom of diseased structure must now be removed, especial care being taken to clear out any caseating abscesses communicating with the joint. All this should be done with as little violence as possible to the surrounding tissues, so that none of the tubercular débris be forced into the fresh-cut surfaces. The best means of removing the disease thoroughly is Mr. Barker's "flushing gouge" (Fig. 326). This has a cutting scoop-like edge, is perforated, and to its belt is attached tubing which communicates with an irrigating can. By this means boiled water

(F. 105°) is kept flowing through the area of operation carrying away the débris of disease whether from abscess cavities, the joint, or the surface of the acetabulum, if diseased, and with it all blood, while at the same time it arrests hæmorrhage. When every part of the field of operation has been gouged and scraped clear of all tubercular material, and the water runs clear, the cavity is dried out with carbolised sponges, one or two of which are left in it, until all the sutures are *in situ*. These should dip deeply, and be placed close together. Just before they are tied, the sponges are removed, and with them the last trace of moisture. The wound is then filled up with iodoform emulsion, and the sutures are tied,

FIG. 326.



Barker's flushing gouge. (Down's Catalogue.)

as much of the emulsion as will come away being squeezed out at the last moment. Graduated, even pressure is then applied by the dressing and bandages, so that the walls of the cavity are brought into apposition, and the remainder of the neck of the femur secured in the acetabulum. The patient is then placed in a double Thomas's splint.

I have only space here to urge that cases of hip excision should be got up as early as possible—*i.e.*, at the end of six or eight weeks. A double Thomas's splint, with foot-pieces, should be applied immediately after the operation, and worn for a period of from four to eight months. After this the child should get about on a patten and crutches, swinging the affected limb. He should not be allowed to use this for upwards of a year after the operation. If weight is borne on this earlier, it is pushed upwards on to the dorsum ilii, and much shortening is the result. Mr. Barker has allowed some of his cases to get up and dispense with a splint at a much earlier period. I think the above given dates better suited to these cases of excision of the hip, when we remember the risks to which they are exposed by their rough-and-tumble life when they leave the hospital.

Usual Causes of Failure after Excision of the Hip.

1. Persistent pelvic disease. 2. Chronic osteo-myelitis of sawn end of femur. 3. Suppuration and hectic. 4. Lardaceous disease. 5. Tubercular conditions elsewhere. General outbreak of tuberculosis. 6. Disease of the opposite femur.

Bruns, of Tübingen (*Beitr. z. Klin. Chir.*, vol. xxii. part i. Tübingen, 1894), shows from carefully recorded cases that about two-thirds of the deaths after resection were due to a general tuberculosis or tuberculosis of other organs, one-third only being caused by suppuration and its sequelæ, septic infection, exhaustion, or amyloid disease.

CHAPTER II.

OPERATIVE INTERFERENCE IN DISLOCATION OF THE HIP.

HERE three varieties of cases have to be considered. I. TRAUMATIC DISLOCATIONS. II. DISLOCATIONS FROM DISEASE (this is rather a partial dislocation, or a subluxation). III. CONGENITAL DISLOCATIONS.

I. TRAUMATIC DISLOCATION.—The great deformity, permanent crippling, and often great suffering resulting from old unreduced dislocations of the hip, abundantly justify resort to operation, nowadays, as long as it is understood that the operation may be a severe one, and the after-treatment one requiring great vigilance on the part of the surgeon to maintain asepsis.

In an excellent paper (*Ann. of Surg.*, Sept. 1894, p. 319) Dr. M. L. Harris of Chicago, publishes an instructive case of his own and twenty-four others which he has collected. From these he draws the following conclusions: (1) Owing to the danger of fracturing the neck of the femur (*Arch. f. Klin. Chir.*, 1885, Bd. xxxii. S. 440); laceration of the great vessels of the thigh (*Ann. of Surg.*, June 1892, p. 425); here, in an attempt to reduce by manipulation an obturator dislocation of thirteen weeks' duration in an adult, a fatal tear was produced at the junction of the superficial and deep femoral veins); shock, and death (*Rev. d'Orthop.*, Sept. 1890) the application of great force to reduce old dislocations of the hip should be discontinued in favour of freely opening the joint and reducing the head of the bone, after the method used by Dr. Harris (*vide infra*). This is the treatment which gives the best results. (2) That subcutaneous operations in old dislocations are without benefit. (3) That as osteotomy below the great trochanter leaves the head in its abnormal position and thus fails to relieve the pain which so frequently accompanies these old dislocations, and as it cannot improve the limited mobility which is always present, it is not to be considered in any way an operation of choice. (4) Resection is only to be thought of when reduction after free arthrotomy fails.

The following are the steps of the **operation** performed by Dr. Harris in his case of dorsal dislocation of nearly four months standing, in which repeated and prolonged attempts at reduction had been made:

An incision about fourteen centimetres in length was made in front* of the great trochanter between the tensor vaginae femoris and the gluteus medius, thus leading directly down to the acetabulum and anterior surface of the head and

* In a case of traumatic dorsal dislocation in a boy, aged seven, reduced after five months by the open method, and brought by Dr. Spencer before the Clinical Society, Feb. 8, 1895, a long anterior incision showed the acetabulum to be filled with dense fibrous tissue. It is stated that the acetabulum could not have been reached by a posterior incision without resecting the head of the bone.

neck of the femur. As was expected, the acetabulum was found filled with a tough, adherent connective-tissue proliferation from the anterior portion of the capsular ligament, which, in falling over the cavity, completely closed it. On cutting through the capsular ligament, the head of the bone was found resting on the posterior and superior edge of the acetabulum in a shallow depression, the lining of which had a smooth cartilaginous feel. Immediately in front of the head and helping to fill the cotyloid cavity was a piece of bone, curved in shape, about three centimetres in length by one centimetre in depth and 0.5 centimetre in width, which had been detached from the posterior wall of the acetabulum. This may have been an obstacle to the early reduction of the case. The head of the bone was still covered with smooth cartilage, while the neck had acquired new firm adhesion to all the surrounding parts, thus producing a new capsular ligament.

A restoration of the ligamentum teres could not be demonstrated, but a small portion of it was present in the depression in the head when this was turned out of its new joint. The adhesions to the neck were divided, and all the muscular attachments to the great trochanter and shaft as far down as the lesser trochanter were separated sub-periosteally from the bone, thus liberating the entire upper end of the femur. Attention was then directed to the acetabulum, which, by means of the gouge and sharp spoon, was freed of capsular ligament and the new connective-tissue formation. The cartilage lining the bottom of the cavity was found to be still smooth. The head of the bone, however, could not be made to enter the acetabulum, which seemed too small. The cavity was consequently enlarged somewhat posteriorly with the gouge and mallet, after which, by considerable exertion and manipulation, the head was finally returned to its place, and the leg assumed its normal position. The wound was partly stitched up, and the rest packed with iodoform gauze. The limb was placed in the extended position, plaster of Paris put on, and extension applied. The operation was a very severe one, occupying fully two hours. The patient suffered considerably from shock, although the loss of blood was not great. Reaction came on promptly, and the progress of the case was favourable from the start. There was considerable serous drainage from the wound during the first few days necessitating rather frequent renewals of the dressings. In three weeks the wound was closed, but in another week a small collection of sero-pus required evacuation by a counter-puncture. The extension was continued three weeks. Six weeks from the time of the operation, the patient was allowed up on crutches. In three months he could walk with a cane without pain in the hip. There was active motion in all directions—flexion, abduction, adduction, and rotation. which, though limited, were daily increasing.

ii. DISLOCATION FROM DISEASE.—This has been referred to at p. 1144.

iii. CONGENITAL DISLOCATIONS.—The advisability of operative interference here is still much disputed. When we consider the conditions of the parts affected, especially the shallow, ill-developed acetabulum, and the altered flattened head, we can easily understand the difficulty which has been met with in getting the head into, and retaining it in, a satisfactory position. Certainly the results which have been attained in England and America do not equal those claimed by the Continental Surgeons Hoffa and Lorenz. Finally, it is equally certain that whatever benefit results is to be attained only at considerable risk (*vide infra*), and that the amount claimed is sometimes open to dispute.*

As long as the technique of these operations requires so much interference with the parts, as long as the risks of sepsis, shock, &c., are so great, no operative

* See a case brought before the Clinical Society and the remarks made at the discussion (*Brit. Med. Journ.*, vol. i. 1895, p. 365).

steps should be undertaken unless the risks and the results have been fully put before the friends.

Choice of Operations.—In children under ten, Hoffa's* operation of division of the retaining shortened structures and replacement of the head of the bone in the acetabulum which should be deepened, may be performed, or a new acetabulum may be made. In older patients, *e.g.*, ten to sixteen, if the deformity is really severe and disabling, Kirrmisson's† sub-trochanteric osteotomy with subcutaneous division of the adductors may be tried.

Operation.—The following account of Hoffa's is taken from an article by Dr. T. H. Myers, (*Ann. of Surg.*, August 1894, ‡ p. 144):

Opening the joint by Langenbeck's incision, division of the capsule at its insertion in the neck of the femur, and sub-periosteal freeing of the great trochanter from all the muscles attached to it are the first steps. In patients under five years old it is then almost always possible by flexion of the thigh and direct pressure upon the head to bring this into the old acetabulum. The hip and knee now are often seen to be flexed. Hoffa overcomes this in young children by holding the head firmly in the acetabulum while an assistant gradually extends the leg on the thigh, so stretching the biceps, semi-membranosus, and semi-tendinosus. This is accomplished in three to five minutes. In older children, six years and upward, it is generally better to divide these muscles, and this is done before opening the joint. Hoffa has adopted Lorenz's recommendation of dividing them at the tuber ischii.

The limb is now abducted, and the adductors subcutaneously divided. The limb is now hyper-extended and the soft parts attached to the anterior superior spine of the ilium, and the fascia lata are divided, by the open method so as to control better the hæmorrhage. These wounds are now dressed and then the joint is opened as described above. The head must be freed so completely that it can readily be brought out of the wound. Hoffa has never seen any necrosis of the head follow this free division. The ligamentum teres, if present, must be extirpated, and the insertion of the capsule into the neck freely divided. A sharp Volkmann's spoon, bayonet-shaped, is now guided by the index finger to the acetabulum, and the fatty tissue and cartilage and a good deal of spongy tissue are scraped out, taking care to preserve the edges of the acetabulum. The cavity must be made not only deep but broad. This is best accomplished by cutting away posteriorly.§

* Hoffa's operation was first described, April 1890, *Verhandl. Deutsch. Gesellschaft f. Chir.*, p. 944. He is stated (*Ann. of Surg.*, August 1894, p. 145) to have operated *seventy-five times*, and is clearly an enthusiast. He lays great stress on the age. The younger the child the better the result. This is readily intelligible, but the increased risks after operation (*vide infra*), at this early age, must not be forgotten.

† *Revue d'Orthopédie*, No. 2, 1894.

‡ Hoffa makes use of a posterior incision, as he believes that the structures which chiefly require division are the muscles attached to the great trochanter and tuber ischii. Lorenz and others who believe that it is the Y ligament which is the chief obstacle to reduction, recommended the anterior incision when this is made use of, another running transversely outwards may be needed to give access to the acetabulum.

§ Mr. W. A. Lane advocates (*Clin. Soc. Trans.*, vols. xxvi. p. 118, and xxviii. p. 294) "replacing the insecure joint by a secure one beneath the anterior superior spinous process. The head of the femur is fixed in a cavity cut in and beneath the anterior inferior spinous process, and the femoral part of the anterior portion of the capsule is sewn firmly to the fibrous tissues about the anterior inferior

The head is now reduced, and goes into its place with a snap. If there is any rotation forward of the neck and head, the limb must be put up in moderate inversion, otherwise the head will slip out of the new acetabulum. After a few weeks it may be brought to the normal position. Lorenz in such a case also advises putting the limb up in inversion, and a subsequent sub-trochanteric osteotomy to correct this.

The superfluous part of the capsule is extirpated, and the wound packed with iodoform gauze. Careful passive movement is begun in three or four weeks, and after five weeks the child is allowed to stand and walk in an apparatus which allows of motion of the hip, but does not allow the head to escape from the acetabulum.

It remains to allude to the results of operative interference both good and bad, though but little has been heard of the latter. Redard (*Traité de Chir. Orthoped.*, Paris, 1892, p. 534), Dr. T. H. Myers and Dr. V. P. Gibney of New York (*Ann. of Surg.*, August and December 1894) accept the following conclusions: "(1) The number of perfect cases is very small. (2) The number of cases improved is large. (3) The results in double dislocation are not so favourable as in single. (4) The lordosis is generally corrected. (5) The limp persists to some degree, though a high shoe will improve this greatly. A paper by Dr. E. H. Bradford of Boston is especially instructive as it contains an account of a specimen taken from a child who died of diphtheria and septicæmia a month after Hoffa's operation had been performed. He considers that while "the method of operative reduction offers the best prospect of a cure, it involves risk and is not certain in its result."

Finally as to the risks. These are certainly serious. The following have been published: 1. Shock. 2. Hæmorrhage. 3 and 4. In young children the effects of the anæsthetic and of iodoform intoxication must also be remembered, together with the above. 5. Peritonitis. This has followed in one case, after perforation of the bone in fashioning the acetabulum.* 6. Septic conditions. 7. Prolonged suppuration. Dr. Gibney (*loc. supra cit.*), with candour that does him great credit, says that profuse suppuration followed in the majority of his nine cases (seven of these were cases of congenital dislocation). This continued for many weeks and months, during which time the wound should have been healed and movements begun. 8. Recurrence of the faulty position.

spine and to the straight head of the rectus at its origin, it having been cut carefully away from its attachment to the innominate bone so as to leave quite enough to make a strong retaining ligament in its new position."

* A gouge and mallet were being used (*Revue d'Orthopédie*, January 1893).

CHAPTER III.

OPERATIONS ON THE THIGH.

LIGATURE OF THE COMMON FEMORAL.—LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE.—LIGATURE OF THE SUPERFICIAL FEMORAL IN HUNTER'S CANAL.—PUNCTURED AND STAB WOUND IN MID-THIGH.—AMPUTATION THROUGH THE THIGH.—AMPUTATION IMMEDIATELY ABOVE THE KNEE-JOINT.—REMOVAL OF EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE. — UNUNITED FRACTURE OF THE FEMUR.

LIGATURE OF THE COMMON FEMORAL.

THOUGH this operation is not regarded with much favour, especially for aneurism, it will be described here, as the question of tying it arises from time to time, and as it should always be performed, for the sake of practice, on the dead body.

Indications.

1. Wounds.—These are rare, here, compared with those affecting the vessels lower down. The wound must always be explored and the bleeding-point sought, for two reasons—(a) Ligature of the external iliac will usually fail to arrest bleeding from the common femoral. (b) The source of the bleeding may easily be mistaken here; thus, Mr. Liston,* in a case of pistol-shot wound of the groin, tied the external iliac for what was proved, post mortem, to have been a wound of "one of the superficial branches of the common femoral, about $\frac{1}{2}$ inch below Poupart's ligament."

After ligature for gun-shot injuries, whether for direct or for consecutive bleeding unattended by primary injury to the vessel, the mortality in the American war † seems to have been high—over 70 per cent.

* *Med.-Chir. Trans.*, vol. xxix. p. 107. The flow of the blood here is said to have been "most impetuous and profuse." In Mr. Liston's words: "The division of even a small branch close to the principal vessel, it is well known, pours out blood furiously, as much so, in fact, as if an opening in the coats or the artery itself were, so to say, punched out, corresponding in size to the area of the branch,

† Otis, *Medical and Surgical History of the War of the Rebellion*, part iii. pp. 16, 43, 49.

The very important subject of **ligature of the femoral artery or vein, or both, in cases of wounds**, will be referred to here, though briefly. Such cases will arise most frequently in removal of growths *e.g.*, epitheliomata, lymphomata, sarcomata—less often in cases of stabs. Much interesting information on these subjects will be found in papers by M. Kirrison* and Dr. L. Pilcher.†

2. Removal of Growths from Scarpa's Triangle and Injury to Femoral Vessels. M. Kirrison has drawn attention to the following points: In the course of the deeper dissection the pulsation of the femoral artery should be frequently felt for with the finger. As this vessel may have been displaced, it is not enough to trust to anatomical knowledge alone. After separating the structures on either side of the growth, this should be left adherent where it is in connection with the sheath, and especial care devoted to this spot. Where the adhesions are very firm, and where a large growth surrounds the sheath, it is useful to divide the growth and to remove large parts of it, only preserving that part in intimate connection with the vessels, this being finally separated most carefully. In the case of growths in intimate connection with the sheath the vein is particularly in danger, because (a) the vein-walls are much more quickly invaded than the arterial, and (b) the vein is in closer connection with the glands. Two conditions are likely to be met with by the surgeon: 1. Denudation of the vessels. Here the adhesions are sufficiently loose to be separated, and the sheath is either left intact or opened. Every effort must be taken to keep the wound here aseptic. 2. Resection and ligature of one or other of the femoral vessels. If the vein alone has been injured in an operation or by a stab, it should be secured if possible by a laterally applied ligature, by the application of Spencer Wells' forceps left *in situ* for two or three days,‡ or by suture of the walls. All of these formerly hazardous procedures have been rendered much safer by the precautions of aseptic surgery. Maubrac (*Arch. Gén. de Méd.*, 1889) strongly advocates lateral suture, especially when the lesion is small. Kammerer (*New York Med. Journ.*, 1890, vol. i. p. 511) points out that suture of the wall has undoubted advantages and that it has been used successfully in the case of the femoral vein, by Schede (*Arch. f. Klin. Chir.*, Bd. xxviii. p. 671), and Lange (*New York Med. Journ.*, vol. xlv. p. 720). If these steps are impossible, or fail, the femoral vein must be ligatured. Dr. Pilcher, quoting from a paper of Braun's,§ shows that of eighteen cases in which ligature of the femoral vein alone was practised at the level of Poupart's ligament, thirteen occurred as the result of wounds inflicted during the removal of growths. In none of these thirteen cases did gangrene ensue.||

* *Rev. de Chir.*, May 10, 1886. I am indebted for my knowledge of this paper to an abstract by Mr. T. Jones, of Manchester (*Med. Chron.*, September 1886, p. 514).

† *Annals of Surgery*, February 1886.

‡ A case in which I thus treated a wound of the internal jugular has been recorded at p. 451. Pilcher mentions a case of Küster's, in which a wound in the vein was secured with hæmostatic forceps; the removal of these after only twenty-four hours was followed by renewed bleeding, ligature of the femoral artery, and fatal gangrene.

§ *Arch. f. Klin. Chir.*, Bd. xxviii. Heft 3, S. 610.

|| Dr. Pilcher points out that this is due to the gradual enlargement of the collateral venous circulation which takes place during the increase of the growth. This constitutes a most important difference between wounds of the vein during operation and by a stab. Thus, in five cases in which as the result of acute injuries the femoral vein was tied high up, recovery without disturbance took place in only one. In two, death took place from septicæmia and pyæmia; in the remaining two, gangrene rapidly supervened. In the case of stab-wounds of the

The question has been raised lately whether, when ligature of the common femoral vein has been found needful, the common femoral artery should not be tied also, in order to diminish the risk of gangrene. Dr. Pilcher, while quoting the cases of Roux, Linhart, and Langenbeck, in which this step was successful, shows that the practice of ligature of the common femoral artery as a prophylactic step after wound of the common femoral vein high up, whether in the removal of tumours or in injuries—*e.g.*, stabs, is to be discouraged.*

Dr. Pilcher suggests (*loc. supra cit.*, p. 119) that where the femoral vein has been suddenly and completely occluded high up it will be wiser to tie not the common but the superficial femoral artery, as likely to materially diminish the current to the limb, while the amount provided will be quite sufficient for its nutrition.

In cases where both vein and artery are wounded these must be secured *in situ*. The risk of gangrene is now enormously increased, though the risk will vary somewhat accordingly as the simultaneous ligature is made above or below the deep femoral.

A few other points bearing upon the removal of tumours here may be alluded to. The internal saphena vein should be carefully preserved intact, and where it is really needful to divide it, this should be done as far from the main femoral trunk as possible, otherwise most troublesome œdema may subsequently develop.†

In operating close to Poupart's ligament, and especially on the inner side, the presence of the peritonæum,‡ and the possible existence of a femoral hernia must be remembered.

3. Ulceration into the Artery by Growths.—From the frequency of growths here this indication will occasionally arise. I have met with one case. A man was admitted under my care who had been operated on elsewhere for the removal of sarcomatous glands in the groin. The application of zinc chloride paste had led to detachment of sloughs and exposure of the common femoral,

common femoral vessels the complication of sepsis has to be remembered. Thus, Mr. Gould (*Med. Soc. Proc.*, vol. x. p. 177) published a case of great interest in which the common femoral vein was wounded ("the whole anterior segment of the vessel" being severed) with a cat's-meat knife. A ligature tied round the vein above and below the wound not arresting the bleeding, the internal saphena which entered the femoral just opposite the wound was tied also. Blood still welled up from the wounded vessel, and further search showed that another vein entered the femoral trunk just opposite the wound in the trunk between the two ligatures. This vein was tied and then all hæmorrhage was found to be arrested. Though the wound was very thoroughly irrigated with solution of hydr. perch. (1-2000), all the infective material introduced by the knife could not be removed. Septic phlebitis followed, with inflammation of the coats of the artery and hæmorrhage on the ninth day necessitating ligature of the superficial and deep femoral arteries. Meanwhile the septic thrombus had been spreading up the iliac vein until all the chief channels for the return of venous blood was blocked. This brought about moist gangrene, the patient dying on the eleventh day with blood poisoning, accelerated by the loss of arterial blood.

* In support of this, Dr. Pilcher writes: "To diminish, to an extreme degree, the arterial supply to a part whose nutrition is already seriously compromised by general venous stasis, would certainly tend to precipitate and aggravate the threatened necrosis."

† Dr. Pilcher (*loc. infra cit.*, p. 214) mentions a case where, after ligature of the saphena vein close to the common femoral, the tendency to œdema was so great that the patient, unfitted for work, begged for removal of the limb.

‡ M. Kirmisson gives a case in which the peritonæum was wounded and sutured, the patient recovering.

which gave way, leading to profuse hæmorrhage. I tied the common femoral immediately above the bleeding-point; this was slowly followed by typical dry gangrene, necessitating amputation through the lower third of the thigh.

4. Ulceration into Femoral Vessels in Inguinal Bubo.—Mr. Shield has drawn attention to this most dangerous condition (*Med. Soc. Proc.*, vol. x. p. 261). Though in his case ulceration occurred in the *superficial* femoral vessels I have alluded to it here, in association with the previous two headings. Owing to hæmorrhage from sloughing sinuses in Scarpa's triangle, Mr. Shield was obliged to tie both artery and vein, using two ligatures in each case. There was no return of hæmorrhage, and gangrene did not occur, but the patient sank exhausted on the eleventh day with a large pyæmic abscess in the opposite hip-joint. Mr. Shield points out that in these most dangerous cases of spreading sloughing bubo, preventive treatment—use of the sharp-spoon, chloride of zinc paste, continuous warm baths, &c.—is urgently indicated. When once bleeding has occurred and recurred, as pressure,* owing to the condition of the soft parts is likely to fail, a free incision and ligature of the vessels above and below the point of ulceration is the wisest course.

5. Aneurism.—There has been much difference of opinion as to whether it is wiser, when dealing with an aneurism on the superficial femoral high up, to tie the common femoral or the external iliac. English surgeons have rejected ligature of the common femoral for these reasons—(1) The risk of gangrene, as the ligature is placed above both the great nutrient arteries of the limb. (2) The probability of firm clotting taking place after the ligature is rendered doubtful, owing to the number of small vessels given off here—viz., the superficial epigastric, and circumflex iliac, the superior and inferior external pudic, and very commonly one of the circumflex arteries, and also by the proximity of the profunda. (3) The uncertainty of the origin of the profunda, and thus of the length of the common femoral. (4) I would add to the above that ligature of the common femoral for aneurism approximates the treatment to that of Anel rather than to that of Hunter. Sir J. E. Erichsen † goes so far as to say, "It may be laid down as a rule in surgery, that in all those cases of aneurism which are situated above the middle of the thigh, in which compression has failed and sufficient space does not intervene between the origin of the deep femoral and the upper part of the sac for the application of a ligature to the superficial femoral, the external iliac should be tied."

Mr. Holmes,‡ while adducing facts to show that the operation on the common femoral is not in itself by any means so fatal as has been represented, and that no just cause whatever has been shown for banishing it from surgical practice, allows that he should be in favour of ligature of the external iliac for femoral aneurism high up, under ordinary circumstances, and reserve that on the common femoral for cases where the belly is extremely fat.

The opposite opinion has been held by some of the Irish surgeons—viz., the two Porters, Mr. Smyly, Mr. Butcher, and Dr. Macnamara. The last-mentioned surgeon has published § eight cases, of which six were successful, two dying of hæmorrhage.

* At the debate on Mr. Shield's paper, Mr. Cripps—a high authority—supported pressure in these cases. It should be applied methodically according to Mr. Cripps' plan (*vide infra*, p. 1166), and, to secure asepsis in these most persistently foul cases, it would be well to try the application of that powerful styptic and disinfectant, turpentine (p. 468).

† *Surgery*, vol. ii. p. 244.

‡ Hunt. Lect., *Lancet*, 1874, vol. ii. p. 300.

§ *Brit. Med. Journ.*, October 5, 1867. Mr. G. H. Porter (*Dub. Journ. Med. Sci.*, vol. xxx. N.S. 1860, p. 302) reports three cases, and alludes to two under his father's care. All were successful, though secondary hæmorrhage occurred in two.

It is probable, however, that, for the reasons given above, ligature of the external iliac will be preferred, especially as, nowadays, antiseptic precautions and improved ligatures will have rendered this operation increasingly safe.

6. As a Preparatory Step to Amputation at the Hip-joint.—The need of this has been largely done away with by the Furneaux Jordan method. Where this is not available, one of the other means given at p. 1135, will, I think, be found preferable.

LINE AND GUIDE.—From a point midway between the anterior superior spine of the ilium and symphysis pubis to the adductor tubercle, and the inner margin of the internal condyle.

Another line is sometimes taken from the centre of Poupart's ligament (or a point midway between the two spines) to the inner margin of the patella or the front of the internal condyle, but that above given is the more correct.

RELATIONS :**IN FRONT.**

Skin; fasciæ; lymphatic glands.

Crural branch of genito-crural. Sheath.

OUTSIDE.

Anterior crural.

Common femoral.

INSIDE.

Septum of sheath.

Femoral vein.

BEHIND.

Sheath.

Psoas.

It is important to note that the common femoral is usually only $1\frac{1}{2}$ inch long, and that from it come off not only the superficial epigastric, circumflex iliac, and superior and inferior external pudic, but occasionally one of the circumflex arteries as well.

Collateral Circulation.**ABOVE.**

Gluteal and sciatic,

with

Superficial circumflex iliac,

with

Obturator,

with

Comes nervi ischiadici,

with

BELOW.

Superior perforating and circumflex arteries.

Ascending branch of external circumflex.

Internal circumflex.

Perforating of profunda and articular of popliteal.

Operation.—The groin having been shaved and cleansed, the hip and knee semiflexed, and the limb abducted and rotated somewhat outwards, an incision about $2\frac{1}{2}$ inches long is made in the line of the artery, commencing just above Poupart's ligament. The skin and superficial fascia having been divided, and any overlying glands displaced or removed, any veins which may be met with descending to join the internal saphena are either drawn aside or tied between double ligatures of chromic gut. The fascia lata having been opened

just below Poupart's ligament, the artery or its pulsation is felt for, the vessel exposed here, and the needle passed from within outwards, care being taken to avoid the crural branch of the genito-crural, which lies superficial to the artery. The neighbourhood of any branch is, if possible, avoided. The wound is then most carefully dried out and closed.

By another method the artery is found by an incision parallel with the centre of Poupart's ligament and about $\frac{1}{2}$ inch below it. This is recommended by Mr. Porter and Dr. Macnamara (*loc. supra cit.*). Of the two, the first, in the line of the vessel, is to be preferred.

LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE (Figs. 327, 328).

Indications.

1. Certain Cases of Aneurism of the Popliteal Artery or the Femoral low down.—Thus the ligature will probably be indicated—*(a)* where a popliteal aneurism is rapidly growing, especially when *(b)* it is on the anterior aspect of the artery instead of behind or at one side of it, as in the former case the knee-joint may become involved after very obscure symptoms; *(c)* when the aneurism is fusiform rather than saccular; *(d)* when it has very thin walls; *(e)* when it threatens to burst, or when this has already happened, unless other symptoms—*e.g.*, gangrene—call for amputation; *(f)* if visceral disease—cardiac, renal, hepatic—or an atheromatous condition of the vessels is present, the surgeon must weigh carefully the question of operative interference: I should prefer in most cases a trial of the ligature as likely, with the aid of antiseptic precautions, a modern ligature and primary union, to entail less taxing of the patient's powers; *(g)* where a trial of pressure has failed, or is certain to fail from the irritability of the patient.

2. Wounds.—Nothing need be added here to what is said on the subject at pp. 1157 and 1165.

3. For Hæmorrhage low down—*e.g.*, after amputation in the middle of the thigh, when other means fail and the wound is nearly united (p. 1167). Two other instances are given by Mr. Bryant (*Surgery*, vol. ii. p. 417). One was “a case of Mr. Bransby Cooper's in which a compound fracture of the leg was complicated with a laceration of the femoral artery. The artery was secured at the seat of injury, and repair went on well in all respects. Mr. Bransby Cooper has also recorded in his *Surgical Essays* a case of fracture of the femur in which the femoral artery was ligatured for a ruptured popliteal artery, and in which recovery took place in six weeks.” Each of such cases must be considered on its own merits, but the above shows what ligature of the femoral artery will do in appropriate cases.

4. For Elephantiasis.—Cases in which the superficial femoral has been tied will be found in the *Lancet* for 1879, vol. i. p. 44:

and Ranking's *Abstract* for 1860, vol. ii. p. 193. The subject of ligature of the main artery of a limb for this affection has been considered at p. 593.

5. Acute Inflammation of the Knee-joint.—Mr. Maunder brought a case before the Clinical Society (*Trans.*, vol. ii. p. 37), in which, at his suggestion, Mr. Little had tied the femoral artery for acute inflammation of the knee-joint, ten days after a lacerated wound. The pain and other acute symptoms were at once relieved, and the patient made a good recovery. The antiseptic treatment of wounds of joints, aided by free incisions, will, nowadays, do away with the need of the above treatment.

LINE.—That above given, p. 1161.

GUIDE.—The above line and the inner border of the sartorius at the apex of the triangle.

RELATIONS.—

IN FRONT.

Skin; superficial fascia; glands; crural branch of genito-crural nerve; middle cutaneous and branch of internal cutaneous; fascia lata; sartorius.

OUTSIDE.

Femoral vein (below). Anterior crural nerve, and some of its branches—viz., the nerve to the vastus internus, and long saphenous nerve.

INSIDE.

Femoral vein (above).

BEHIND.

Psoas; pectineus; adductor longus; femoral vein (below); profunda vein; nerves to pectineus.

Collateral Circulation.

ABOVE.

Perforating of profunda, with

External circumflex of profunda,

Comes nervi ischiadici,

with

with

BELOW.

Lower muscular of femoral, articular of popliteal, and anterior tibial recurrent.

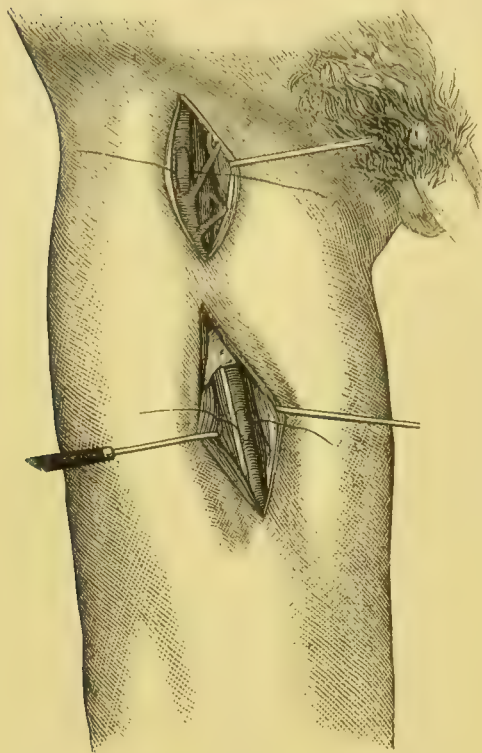
Ditto ditto.

Perforating of profunda and articular of popliteal.

Operation (Figs. 327, 328).—The parts having been shaved and cleansed, the knee and hip slightly flexed, the thigh abducted and somewhat everted, and the leg resting on a pillow, the surgeon, seated or standing to the right of the affected limb, makes an incision 3 inches long in the line of the artery (p. 1161). This should begin about $2\frac{1}{2}$ inches below Poupart's ligament, and run down to, and somewhat below, the apex of Scarpa's triangle, which

lies usually 4 to 5 inches below Poupart's ligament. The skin and superficial fascia having been divided, any small vessels are secured, and branches of the saphena vein drawn aside with a strabismus hook or secured with double chromic-gut ligatures. The deep fascia is now slit up for the whole length of the wound, and the inner

FIG. 327.



Ligature of the common femoral, and the superficial femoral at the apex of Scarpa's triangle. The ligature in each case has been passed from within outwards. (Sédillot.)

margin of the sartorius, which crosses the lower part of the incision, identified. This is then turned outwards, and so held with a blunt hook or retractor, while the artery or its pulsation is felt for. The wound being now well opened out with retractors and carefully wiped out, the sheath is opened to the outer side, care being taken to avoid the nerves in contact with it—viz., the long saphenous, or the nerve to the vastus internus. The artery having been cleaned, thoroughly but most carefully, on either side and behind, the needle is passed from within outwards, being kept very close to the vessel so as to avoid the vein which lies behind and internally.* The artery having been tied, the ligature is cut short, drainage provided by horsehair or a small tube, according to the amount of disturbance of the parts, &c., and the wound

closed. The precautions given at p. 597 for the prevention of gangrene must be taken.

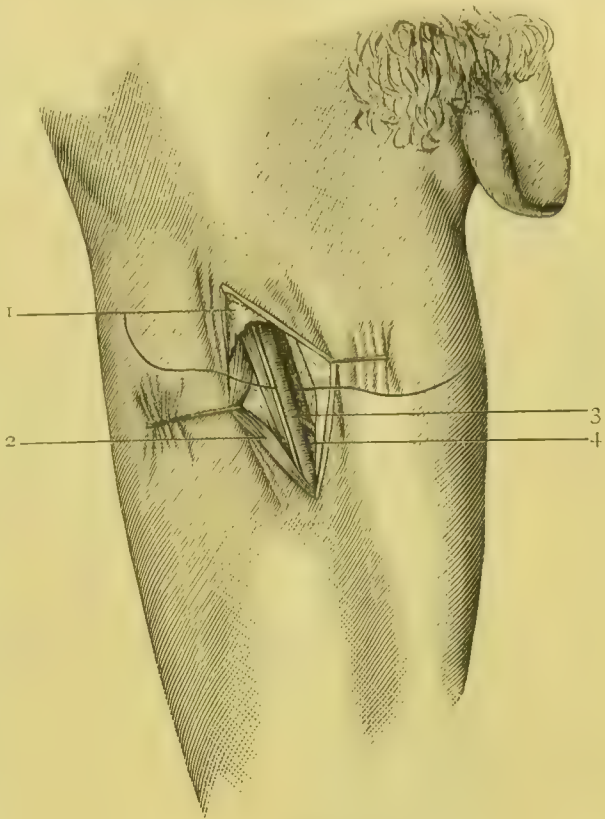
Difficulties and Mistakes.

1. Wounding the Saphena Vein.—This may occur if the incision is made too internal. It is always to be avoided if possible, owing to the troublesome cedema which may follow. 2. A very broad

* The vein is so frequently damaged here, especially on the dead subject, that a few precautions may be given as to the best way of avoiding it. First, the sheath must be identified exactly, and sufficiently opened at its outer part. It will be found of much help in cleaning the vessel if one edge of the cut sheath is held by an assistant, while the surgeon has hold of the other; the opening in the sheath is thus made sure of and retained. There must be no needless disturbance, or lifting up of the vessel upon the needle, which, with the director, must be used with the utmost carefulness. As soon as the eye (and this should be at the very end of the needle) is seen to have passed round the vessel the ligature should be at once seized and the needle withdrawn.

Sartorius. 3. Injury to the Femoral Vein.—This may easily take place if force is used in pushing the needle round an imperfectly cleaned artery, or if the needle is not kept close to the vessel.

FIG. 328.



Dissection of parts concerned in ligature of the femoral artery at the apex of Scarpa's triangle. 1. Fasciæ. 2. Sartorius. 3 and 4. Superficial femoral artery and vein.

If the accident occur, the surgeon must not persist in his attempt to tie the artery at this spot, a course which will only end in his inflicting more injury on the vein, but finger-pressure being made in the lower angle of the wound, the artery is tied either above or below the spot where the vein has been injured. As soon as the artery is secured, no further hæmorrhage will take place, but pressure may be kept up by means of sterilised dressings over the wound for a day or two.* The patient will do well to wear a Martin's bandage or an elastic stocking for some time after getting up. 4. Including one of the nerves. 5. A matted condition of the parts due to a previous trial of compression.

Abnormalities of the Femoral Artery.

1. A double superficial femoral, the two trunks uniting below to form the popliteal. More than one case of this kind is recorded. The persistence of pulsation in the aneurism after the first ligature would lead to a suspicion of this condition. 2. The vessel may run down at the back of the limb.

LIGATURE OF FEMORAL ARTERY IN HUNTER'S CANAL (Fig. 330).—TREATMENT OF A STAB IN MID-THIGH (Fig. 329).

Indications for Ligature of the Femoral Artery in Hunter's Canal.

1. Wounds.—These may be, (a) incised; (b) punctured.

* If venous hæmorrhage persist, the opening in the vessel should be secured with a chromic-gut ligature, or a pair of Spencer Wells' forceps left *in situ* (p. 1158.)

(a) Here, if immediate death from hæmorrhage has been arrested, the wounded vessel must be secured. The artery above being compressed by an Esmarch's bandage or the hands of an assis-

FIG. 329.



Incised wound of the thigh explored and found to involve the femoral artery. An Esmarch's bandage should have been shown *in situ* above.

tant, the wound is enlarged, clots are sponged away, and the artery tied above and below the wound in it (Fig. 329). If the vein is injured too severely for a laterally applied ligature (p. 1158), and requires ligature in the ordinary way, the patient or the friends must be prepared for the imminent need of amputation.

(b) If a punctured wound lies in the line of the artery (p. 1161), and if much blood has been lost, the main trunk is probably injured, and the question will arise, if the bleeding has ceased, whether to cut down upon the artery or to trust to pressure. Mr. Cripps (*Dict. of Surg.*, vol. i. p. 525) advises that, if the wound be in the upper part of the thigh, "the surgeon may enlarge the wound with a good prospect of finding the wounded vessel without an extensive or prolonged operation. If the wound be in the lower half of the thigh, owing to the greater depth of the artery and the possibility of its being the popliteal which is wounded, the search is rendered far more severe and hazardous, and it should not be taken until a thorough trial of pressure has proved ineffectual."

The following mode of applying pressure is taken from Mr. Cripps (*loc. supra cit.*)* I would also refer my readers to the account of punctured wound of the palm given at p. 23 of this work.

The main vessel having been controlled above, the foot and leg

* Mr. Cripps' account will be found under the heading of the treatment of secondary hæmorrhage from the femoral. He draws attention to the instructiveness of the literature of this subject, as it proves not only that many cases have been successfully treated by pressure from the first, but that both life and limb have been saved by pressure after the surgeon has failed to find the artery in the wound, or after the iliac has been tied in vain.

should be carefully strapped from the toes to the knee, and a bandage then carried from the toes up to the wound, and then, avoiding this, up to the groin, where it is secured, spica-fashion, over a pad on the main artery. The limb is then laid on a long back splint with a foot-piece, and secured to this in an elevated position. The wound having been cleansed and dusted with iodoform, a graduated compress (p. 24) is then fastened over it. Two rectal bougies are then applied in the course of the artery, above and below the wound, outside the bandage which surrounds the limb, so as to keep these segments of vessel empty. Two well-padded lateral splints are then secured with straps and buckles to the thigh. Morphia must be given as freely as is judicious.*

2. Hæmorrhage from a Stump after Amputation in the Lower Third of Thigh or Knee.—If clearing away the clots and disinfecting the stump, followed by well-adjusted pressure, and, this failing, trying to find the bleeding point in the flaps, do not suffice, the artery must be tied above.†

LINE AND GUIDE (p. 1161).

RELATIONS :

IN FRONT.

Saphena vein.

Skin; fasciæ; sartorius; aponeurosis between vastus internus and adductors.

OUTSIDE.

INSIDE.

Vastus internus; vein (slightly). Adductor longus and magnus.

Femoral artery in Hunter's canal.

BEHIND.

Femoral vein (especially above).

Operation (Fig. 330).—The knee and hip having been flexed, and the limb abducted and rotated outwards, the surgeon, seated comfortably on the inner side of the limb, makes an incision $3\frac{1}{2}$ inches long in the line of the artery in the middle third of the thigh.‡ The skin, superficial and deep fasciæ, having been divided, and the saphena vein drawn to one side with a strabismus hook, and any of its branches divided between double chromic-gut ligatures, the sartorius is identified by the direction of its fibres and drawn

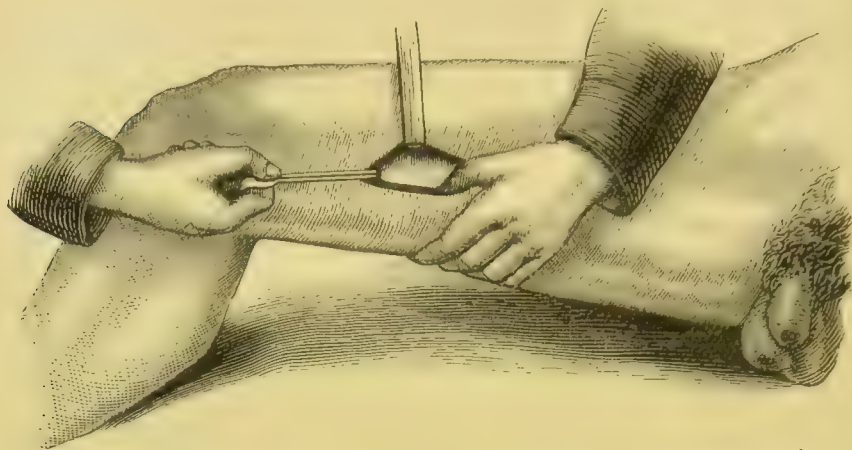
* Mr. Cripps advises that the limb should be slightly raised on a pillow, and partly bent at the knee and thigh. The toes should be left exposed that their condition may be watched.

† I would again refer my readers to Mr. Cripps' article (*loc. supra cit.*, p. 526). He points out that a decision between opening the flaps or ligaturing the main vessel high up must depend on the amount of union, and that if the flaps must be opened and the vessel sought for before there is much firm union, as in the first fortnight, a director should be used rather than a knife, and that if the vessel is found, its soft condition will require very gentle tying.

‡ This incision must not be made too low down. Its centre should correspond to the centre of the thigh.

to the inner side. The canal is next opened by dividing the aponeurotic roof, and the artery or its pulsation felt for. This vessel will be found closely connected to its vein, which lies

FIG. 330.



Ligature of the femoral artery in Hunter's canal. The surgeon standing outside finds the furrow between the adductors and the quadriceps, and then makes an incision in the line given at p. 1161. The lower lip of the wound having been depressed with the left thumb, the deep fascia is divided on a director. (Farabeuf.)

behind it, while the saphenous nerve crosses it from without inwards. The artery having been most carefully cleaned all round, the ligature may be passed from either side, as is found most convenient.*

Causes of Failure after Ligature of the Femoral.

1. Gangrene. 2. Secondary Hæmorrhage.—If pressure fail, an attempt must be made to re-tie the vessel, and, this not succeeding, the limb must be amputated. 3. Suppuration of the Sac of an Aneurism.—This is very rare. 4. Recurrent Pulsation in the Aneurism.—The premature softening of catgut, especially in a septic wound, must always be remembered as a possible cause of this. Pressure failing, the artery may be tied lower down. 5. A very rare complication is the formation of an aneurism at the seat of ligature.

* Much difficulty will be met with in tying the femoral artery in Hunter's canal unless the line of the artery (p. 1161) is strictly followed. A common mistake is to make the incision too far out, thus exposing the fibres of the vastus internus, which run downwards and outwards, instead of those of the sartorius, which run downwards and inwards (Smith and Walsham, *Man. of Oper. Surg.*, p. 83). Sir J. E. Erichsen (*Surgery*, vol. ii. p. 250), who gives as the line of the artery, one drawn from a point exactly midway between the anterior superior spine and the symphysis pubis to the most prominent part of the internal condyle, insists on the need of making the incision a finger's-breadth internal to this. The line which I have given above will be found sufficiently internal.

AMPUTATION THROUGH THE THIGH.

(Figs. 331-334.)

Practical Points in Amputation of the Thigh.—As the soft parts behind are more bulky than those in front, and as it is desirable to place the bone as near as possible in the centre of the soft parts, the back of the thigh, in the case of a bulky limb, may be supported by the hand of an assistant during the first introduction of the knife to form the anterior flap (Skey). Amputation should always be performed as low down as possible, not only to avoid shock and to secure as long a stump as possible for the artificial limb, but also to secure as much as possible of the rectus femoris. This muscle is a most important agent by which the thigh is put forward in stepping. Its division does not preclude the retention of its office, as it acquires a sufficient adhesion to the material of the stump to answer every useful purpose, as an agent in the flexion of the thigh on the pelvis, though that of extension of the leg be destroyed (Skey, *Oper. Surg.*, p. 391).

Different Methods.—The following five, which will give ample choice, will alone be described here; the first is especially recommended:

I. Mixed Antero-posterior Flaps and Circular Division of the Muscles. II. Antero-posterior Flaps by Transfixion. III. The Circular Method. IV. Rectangular Flaps. V. Lateral Flaps.

I. **Mixed Antero-posterior Flaps and Circular Division of the Muscles** (Fig. 331).—By the term mixed is meant an anterior flap of skin and fasciæ raised from without, and a posterior one made by transfixion. The anterior is, wherever practicable, made the longer of the two.

This method has the following great *advantages*: (1) The longer anterior flap falls well over the bone, and thus keeps the scar behind; (2) Being raised from without inwards, it can be taken from the neighborhood of the knee-joint and patella; (3) It is a most expeditious method,* almost as quick as that by double transfixion flaps; (4) It is suited to all cases, save perhaps those of very muscular thighs, where the surgeon should be careful to take only part of the muscles behind as he transfixes, or else should raise his posterior flap also from without inwards; (5) It gives good drainage.

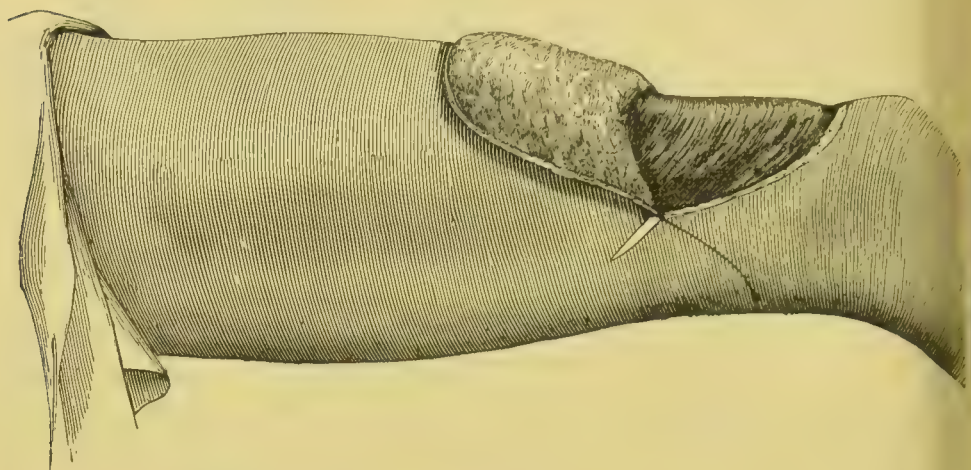
Operation.—The femoral artery having been controlled with an Esmarch's bandage,† the limb being brought over the edge of the table, and supported by an assistant, who has bandaged the damaged or diseased part to give his hands a firmer grip, and to prevent their becoming septic; the opposite ankle being tied to

* As in railway and other accidents.

† If the surgeon is amputating very high up, the method given in the account of amputation at the hip-joint (p. 1130) may be used.

the table, and the parts duly cleansed, the surgeon standing to the right side of the limb to be removed, places his left index and thumb on either side of the limb, at the level where he intends to saw the bone,* and sinking the point of his knife through the skin just below the former and rather below the centre of the outer or inner aspect of the limb, as the case may be, carries it rapidly down for about $4\frac{1}{2}$ inches, and then sweeps it across the limb with a broad, not pointed, convexity, and carries it up along the side nearest to him as far as his thumb. This flap is then quickly dissected up of skin and fasciæ, and the knife, being sent across the limb, behind the bone, cuts a posterior flap almost as long as the

FIG. 331.



The knife should have been inserted here from the inner side.

anterior, the knife being used with a rapid sawing movement, and driven at first straight down parallel with the bone, and then sharply brought out through the skin.

The flaps being held out of the way with the surgeon's left hand,† the soft parts around the femur are next severed with circular sweeps‡ (p. 1173), till the bone is exposed, when one more firm sweep divides the periosteum.§

The saw is now placed with its heel on the bone and drawn towards the operator once or twice with firm pressure so as to make one groove, and one only. With a few sharp sweeps the bone is next severed, care being taken to use the saw lightly for fear of splintering the *linea aspera*, and to use the whole length of the instrument. At this time the limb must be kept steady and

* The finger and thumb should not be shifted till the anterior flap is marked out.

† And also pressed firmly upwards, so as to enable the saw to be applied as high up as possible. If the limb is bulky an assistant must help here.

‡ This requires really forcible use of the knife, the muscles behind the bone tending to be pushed before the knife rather than divided by it.

§ This final cut should be a little above the base of the flaps, in order that the sawn femur may lie well buried in soft parts.

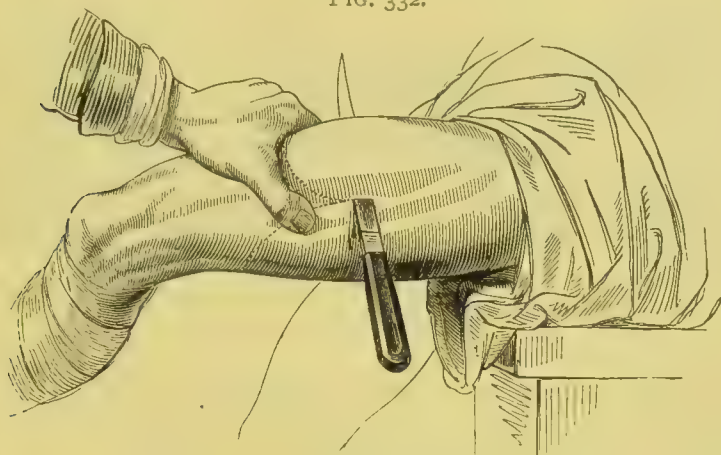
straight, the assistant neither raising it, which will lock the saw, nor depressing it, which will splinter the femur when this is partly divided.

If the surgeon decide to make his posterior flap also of skin and fascia, he must have the limb raised, and first looking over and then stooping down, marks out a skin flap about $\frac{2}{3}$ the length of the anterior; this is then dissected up, and the operation completed as before.

In addition to the femoral vessels, the anastomotica, and descending branch of the external circumflex, some muscular branches will require attention; and one of these last may give some trouble from its position close to the bone, in contact with the *linea aspera*.*

In amputations of the thigh accompanied by grave shock, no

FIG. 332.



(Fergusson.)

needless time should be lost in looking for vessels, save the femoral and any other large branch which can be seen. Firm bandaging and raising the stump will suffice. It is well to partially relieve the tightness of the bandages in a few hours by nicking them. Very few sutures should be used in these cases of shock, or in those where the soft parts are sinus-riddled.

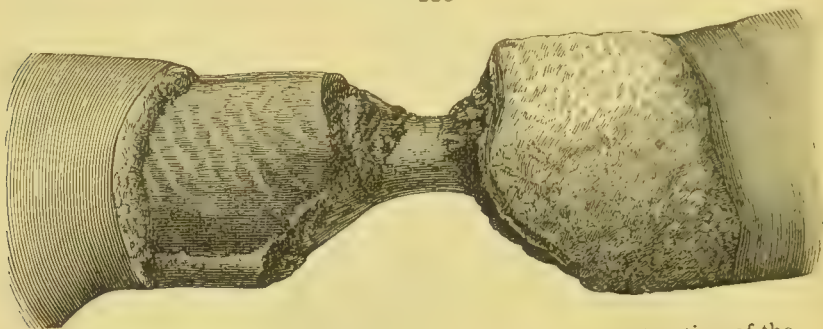
II. Transfixion Flaps (Fig. 332).—*Advantage*.—Great rapidity. *Disadvantages*.—Those given at p. 57, on a large scale. This method may be used where great speed is needed, as in a double amputation after a railway accident, or where many wounded require attention, as after a great battle. It is also adapted to the wasted muscles of a patient who has long suffered from some chronic

* The following points deserve attention in tying the femoral vessels: (1) Not to include the saphenous nerve; (2) the tendency of the vessels to slip up if the point of their division passes through Hunter's canal; (3) if the vessels are atheromatous, they must not be tied too tightly. A carbolised silk ligature, not too fine, should be employed now, and care should be taken to include a little of the soft parts so as to prevent the ligature cutting through.

disease of knee or leg, but even here it is inferior to the mixed method.

Operation.—The preliminary steps given at p. 1169 being taken, the surgeon, standing to the right side of either limb, with his left index and thumb marking the site of his intended bone-section, raises with his hand the soft parts on the front and sides of the thigh, and sends his knife across the limb in front of the femur. The knife should be entered well below, so as to get as large an anterior flap as possible, and, at its entry, should be pushed a little upwards so as to go easily over the bone. An anterior flap is then cut 4 to 4½ inches long, with a broadly curving almost square extremity, and not too thin at its edge. This being raised by the surgeon or an assistant, the knife is

FIG. 333.



Circular amputation of the thigh to show the greater retraction of the muscles behind.

now passed behind the bone, and a posterior flap cut of the same length as the anterior, the making of this flap being somewhat facilitated by drawing the soft parts on the back of the limb away from the bone.

If the limb be very bulky, the knife should be kept well away from the bone, especially behind it, and not as in Fig. 347; thus the more superficial muscles only will be included in the posterior flap.

Both flaps having been retracted, the remaining soft parts are severed with circular sweeps, and the rest of the operation completed, as at p. 1170, but with this difference, that here there will be more need of trimming some of the soft parts clean and square.*

III. The Circular Method.—I may here state briefly why this method is, nowadays, considered inferior, both in the thigh and elsewhere, to that by flaps. In saying this, it is not denied that in many cases stumps by the circular method are fully equal to those by flaps; indeed, in many it is impossible to tell, in later years, which method has been employed. On the whole, however, the

* While dresser to the late Mr. Poland, I once saw the femoral vessels split for about 3½ inches by his rapid hands. This amputation of the thigh was his last operation at Guy's Hospital. He was even then facing with quiet bravery the bronchitis which a very few days later, ended his life.

flap-method has the following *advantages*: (1) It is most generally applicable—*e.g.*, in parts not circular and at the joints.* (2) By it the surgeon can better adapt his skin covering to his needs—*e.g.*, when the skin is less available on one aspect of the limb than on another. (3) There is less risk of a conical stump; and (4) of a cicatrix adherent to the bone. The great advantage of the circular method—*viz.*, that the vessels and nerves are cut square, and that, thus, the former retracting more easily, fewer need securing, while there is less risk of bulbous ends forming on the latter, is attained by the mixed method of skin flaps and circular division of the muscles as advised at p. 1169.†

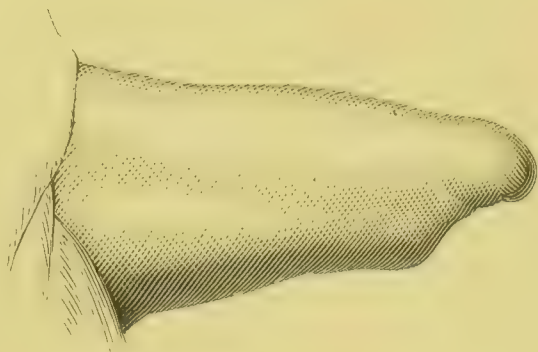
The circular method is only to be adopted here in the case of the lower third of wasted thighs, or in those of young subjects. Even here the greater tendency of the posterior muscles to retract (Fig. 350) must be met by cutting them about $\frac{3}{4}$ inch longer than those in front.

While this operation is for the above reasons

not recommended in practice, it may be made use of in the lower third of the thigh, in the cases mentioned above. On the dead subject the student who has not had a chance of performing it upon the arm may make use of it here.

Operation.—As this method has been described in detail at p. 101,‡ it will be only briefly given here. The preliminaries are those already given. The surgeon standing to the right of the limb, the assistant, who stands on the opposite side to him, but nearer the trunk, draws up the skin with both hands. The surgeon, stooping a little, passes his knife first under the limb, then above, across, and so around it till by dropping the knife vertically the back of the instrument looks towards him, while its

FIG. 334.



Inner aspect of the stump of a left thigh, amputated by the circular method. The powerful tendency of the posterior muscles to retract has not been allowed for, and the stump, in consequence, is conical. (Farabeuf.)

* To these it may be added that the circular method is not adapted to a case where the skin is matted to the subjacent muscles.

† One more advantage of the flap-method is the greater rapidity, especially when transfixion is employed, though this, in these days of anaesthetics, is only of importance in a few cases.

‡ If it be objected that the plan here given of turning up a cuff-like flap is likely to lead to sloughing, I would reply that this is not so in these days of antiseptic surgery. If sloughing is dreaded, a little more time should be taken in dissecting up a thin layer of muscle, so as to secure the deep fascia, and thus a better vascular supply.

heel rests on that side nearest to him. He then makes a circular sweep around the thigh, this being aided by the assistant who has charge of the limb, rotating it so as to make the soft parts meet the knife. The surgeon then taking hold of the edge of the incision dissects up a cuff-like flap, about $4\frac{1}{2}$ inches in length, cutting it of even thickness all round the limb. The flap is then folded back, and the remaining soft parts divided with circular sweeps of the knife. In doing this, the greater contraction of the hamstring muscles must be remembered (Fig. 334), and these muscles cut rather longer than those in front. Care must be taken, if it is thought needful, after making the circular sweeps, to free the bone higher up, and so to secure its being well buried in the soft parts, but not to prick the already divided femoral vessels which lie in close proximity to the femur in the lower third.

IV. Rectangular Flaps of Mr. Teale.—This method is fully described p. 1225. It is not recommended here as it is expensive, involving division of the bone nearer to the trunk than other methods. (1) Owing to the bulkiness of the long anterior flap, it is, here, especially difficult to fold and adjust it at the conclusion of the operation, and, still more so, to keep it adjusted if primary union fails. (2) Its chief advantages, that of keeping the end of the bone well buried, and of cutting the vessels and nerves clean and square, are also sufficiently attained by the other flap methods already given, especially the mixed method (p. 1169).

V. Lateral Flaps.—This method has certain grave objections here. (1) The sawn femur, tilted upwards by the ilio-psoas, is very liable to press against the upper angle of the flaps, and to come through at this spot and necrose. (2) If this does not take place, the bone often adheres to the cicatrix here, while the flaps hang down and away from it.

It should only be made use of when no other method is available, as in a case where, owing to the condition of the soft parts, flaps can only be got by making one long external and a short internal, or *vice versa*.

Operation.—This method will be found fully described at p. 1224.

AMPUTATIONS IMMEDIATELY ABOVE THE KNEE-JOINT (Figs. 335–343).

Methods.

i. Carden's (Figs. 335, 336, 337). ii. Gritti's Trans-condyloid (Figs. 338, 340, 342). iii. Stokes' Supra-condyloid, an important modification of the above (Figs. 339, 341, 343).

All the above, but especially the two latter, possess the following *advantages* (which they share with amputation through the knee-joint) over amputation through the thigh, viz.:

1. The patient can bear his weight in walking on the face of his stump; thus, he is not compelled to take his bearing from the tuberosity of the ischium, or to walk as if he had an ankylosed

hip-joint (Stokes), as is the case after amputation of the thigh, where the stump is ever liable to be fretted by the slightest pressure on it. 2. Very good power of adduction over the artificial limb remains. Every surgeon must have noticed how badly off a patient is in this respect after an ordinary amputation through the thigh. By these methods the adductors are left almost intact, even to part of the strong vertical tendon of the adductor magnus, the result being that the balance between the adductors and the abductors of the thigh remains practically undisturbed, and the patient when walking has none of that difficulty (which is seen after thigh amputations) of bringing the limb which he has swung forwards in again, under the centre of gravity.* 3. The medullary canal is not opened; on this account there is less risk of necrosis and osteo-myelitis if the stump becomes septic. 4. There is less shock, because (a) the limb is removed farther from the trunk, (b) the muscles are divided not through their vascular bellies, but through their tendons.

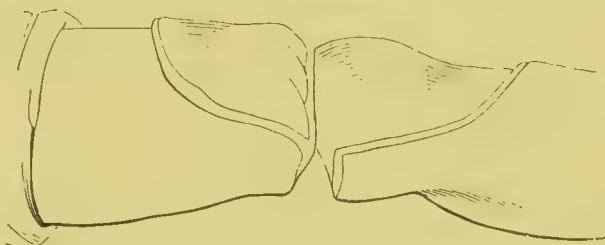
i. Carden's Amputation (Figs. 335, 336, 337).

Advantages.—This valuable amputation has some points in common with Syme's amputation at the ankle-joint. In both the bone-section is made not through a medullary canal but through vascular, quickly healing cancellous tissue; in both, the skin reserved for the face of the stump has been used to pressure, though not equally so, for the skin preserved in the ankle-amputation is thick and callous, in the other thinner and more sensitive.

Sir J. Lister (*System of Surgery*, vol. iii. p. 705) thus recommends this amputation:

"This operation, when contrasted with amputation in the lower third of the thigh, presents a remarkable combination of advantages. It is less serious in its immediate effects upon the system, because a considerably smaller quantity of the body is removed, and also because the limb, being divided where it consists of little else than skin, bone, and tendons, fewer blood-vessels are cut than when the knife is carried through the highly vascular muscles of the thigh; the popliteal and one or two articular branches being, as a general rule, all that require attention, so that loss of blood is much diminished. In the further progress of the case the tendency to protrusion of the bone, which often causes inconvenience in an amputation through the thigh, is rendered comparatively slight by the ample extent of the covering provided, and also by the circumstance that the divided hamstrings slip up in their sheaths, so that the posterior muscles have comparatively little power to produce retraction. The superiority of the operation is equally conspicuous as regards the ultimate usefulness of the stump, which, from its great length, has full command of the artificial limb, while its extremity is well calculated for sustaining pressure, both on account of the

FIG. 335.



(Carden.)

* The importance of the preservation of the quadriceps extensor, given by the Stokes-Griffith method, need only be alluded to.

breadth of the cut surface of the bone divided through the condyles, and from the character of the skin habituated to similar treatment in kneeling. Considering therefore that this procedure can be substituted for amputation of the thigh in the great majority of cases both of injury and disease formerly supposed to demand it, 'Carden's operation' must be regarded as a great advance in surgery."*

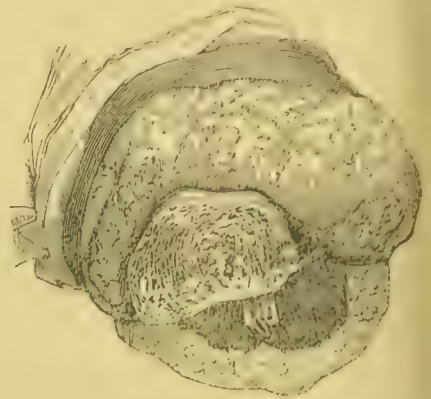
Disadvantages.—The chief of these is the sloughing of the long anterior flap which may occur, "in spite of faultless operating," especially if the skin, of

FIG. 336.



(Carden.)

FIG. 337.



which it chiefly consists, has been damaged by injury or disease, or if the patient be old or weakly, thus leading to an adherent, tender scar, and a useless stump.

Operation.—According to its introducer this amputation consists in removing a rounded flap from the front of the joint (Figs. 335, 336, 337), dividing everything else straight down to the bone, and sawing this slightly above the plane of the muscles.

The operator, standing on the right side of the limb, takes it, between his left forefinger and thumb, at the spot selected for the base of the flap,† and enters the point of his knife close to his finger, bringing it round through the skin and fat below the patella to the spot pressed by his thumb, then turning the edge downwards at a right angle with the line of the limb, he passes it through to the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upwards, and the saw applied "through the base of the condyles." The projecting part of the femur may be rounded off. Where there is any doubt about the vitality of the large anterior flap, a short posterior one should be made, the anterior one thus not needing to be so long (Fig. 353).

ii. **Gritti's Trans-condyloid** (Figs. 338, 340, 342). iii. **Stokes' Supra-condyloid Amputation** (Figs. 339, 341, 343).

For fuller information on the above amputations I would refer my readers to a paper I contributed to the *Guy's Hosp. Reports*, vol. xxiii. p. 211, 1878. The objections to amputation through

* Other advantages given by Mr. Carden are, the favourable position of the stump for dressing and drainage; its painlessness, the chief nerves being cut high up and slipping upwards out of the way; and the cicatrix being drawn clear of the point of the bone, and out of reach of pressure.

† This corresponds with the upper border of the patella, the limb being extended. The lower margin comes down to the tubercle of the tibia, as in Fig. 335. (See also *Brit. Med. Journ.*, 1864, vol. i. p. 416.)

the knee-joint, whether by a long anterior, or long posterior flap, are given at p. 1182. Amputation through the knee-joint by lateral flaps gives excellent results, but in this method the incisions are carried into the leg below the tibial tubercle; in the two amputations mentioned above this level is not trenched upon, and every surgeon knows that after a severe compound fracture of the leg, an inch or two more or less of damage to the soft parts in the upper third of the leg makes a most important difference as to where he can amputate.

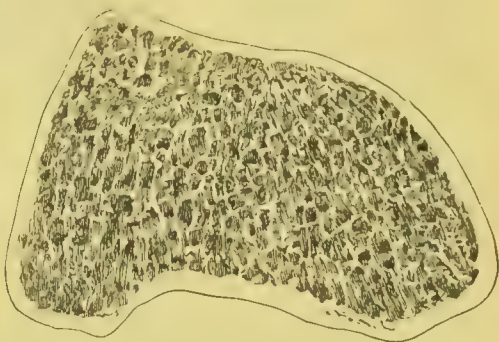
The two methods are often confused. Between them there is this all-important difference: in Gritti's, the section of the femur

FIG. 338.



Gritti's trans-condyloid section of the femur, leaving a surface much too long and large for the sawn patella to fit.

FIG. 339.



Stokes' supra-condyloid section of the femur, leaving a surface much more easily fitted by the sawn patella.

is made *through* the condyles; in Stokes', at least $\frac{1}{2}$ inch *above* them. In other words, the one operation is *trans*-, the other *supra-condyloid*.

On this point great stress has been laid, and very rightly, by Sir W. Stokes, and a comparison of the two operations will convince every one that he is correct. If the section of the femur be made through the condyles (Figs. 338, 340), the sawn patella will not fit down into place. It will either be drawn up altogether on to the front of the femur, or else will project forwards, somewhat like the half-open lid of a box (Figs. 340, 342), at an angle to the broad sawn surface, which is also too large for it to cover, and across, and off which it is liable to be shifted by the contraction of the quadriceps, if it has been found possible to get it into place. To effect this, an amount of force will be required which is almost certain to result in bruising of the cut periosteum on the edge of the femur, and consequent necrosis. If, on the other hand, the saw is made to pass a full inch *above* the condyles (Fig. 339), the patella will fall readily into place (Fig. 341), it will cover more completely the now smaller surface of the femur, and will remain easily *in situ* here, the flaps when brought together presenting the appearance shown in Fig. 343.

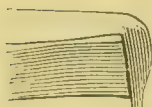
Operation.—An Esmarch's bandage having been applied, the limb brought over the edge of the table and supported, and the opposite one secured out of the way, the surgeon standing to the right of the limb, with his left index and thumb marking the base of the flap,

FIG. 340.



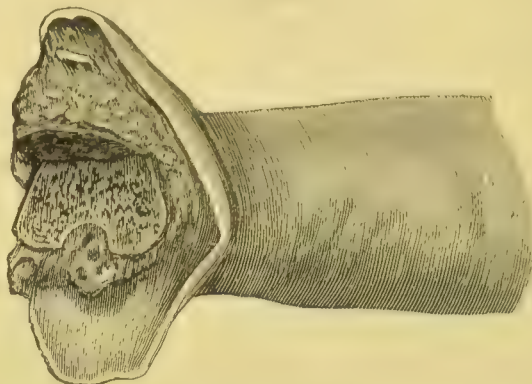
(Farabeuf.)

FIG. 341.



(Farabeuf.)

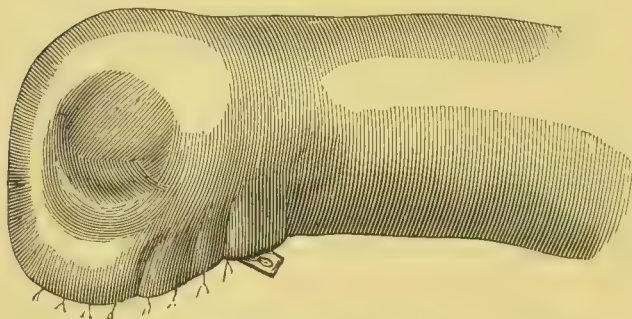
FIG. 342.



The flaps in Gritti's trans-condyloid amputation, showing the patella hitched and requiring force to adapt it to the femur, which is now too long as well as too broad.

makes an incision commencing (on the left side) an inch above and rather behind the external condyle, carried vertically downwards to a point opposite to the tibial tubercle, then broadly curved across the leg and carried upwards to a point opposite to that from which

FIG. 343.



Appearance of the stump in a Stokes-Gritti's amputation. The patella has come easily into place. The drainage-tube shown might, in many cases, be dispensed with.

it started. This flap having been dissected upwards, together with the patella (after section of the ligamentum patellæ), a posterior flap is cut nearly as long as the anterior. This may be effected in one of two ways, either by the surgeon looking over and then stooping a little (the limb being now raised), next drawing the knife

from without inwards across the popliteal space, thus marking out and then dissecting up a skin flap, or by transfixing and cutting the flap from within outwards. Of the two I prefer the first: the latter is the speedier, but less suited to bulky limbs. The flaps being retracted, the soft parts are cut through with a circular sweep a full inch above the articular surface of the femur, the bone is then sawn through here, and the limb removed. The posterior surface of the patella is next removed with a metacarpal or small Butcher's-saw. This last step is the only difficult one in the

operation, owing to the mobility of the bone; it will be facilitated by an assistant with both his hands everting and projecting the under surface of the anterior flap, so as to make the patella stand out from it.

The vessels—popliteal, one or two articular and the anastomotic—having been secured, drainage is provided, and the flaps are brought together with numerous points of suture, save at the angles (Fig. 343).

Where the flaps are cut of proper length and the femur is sawn at the proper height, it is quite exceptional for the patella not to ride easily *in situ*. If there seem any doubt on this point, or if the patient is very muscular, additional security may be given—(a) By passing sutures of chromic gut or carbolized silk between the tissues on the under surface of the anterior flap, at the edges of the patella, and the soft parts in the posterior flap (avoiding the vicinity of the large vessels); (b) by wiring or pegging the bones; (c) by dividing the rectus muscle on the under surface of the anterior flap. Of these, wiring or pegging is the best; the pegs must be scrupulously clean. They should be well boiled beforehand in a solution of hydr. perch. An ordinary bradawl, also rendered aseptic, will be found quite as efficient as a drill.

REMOVAL OF AN EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE.*

As these growths are by no means uncommon in adolescents, this operation will be briefly described here. Aseptic excision has now replaced any other operation such as subcutaneous fracture.

Operation.—The parts having been thoroughly cleansed, the knee is flexed so as to bring down the synovial membrane, and the limb placed on its outer side. A free incision, about $3\frac{1}{2}$ inches long, is made over the growth, down to the vastus internus, and any superficial vessels attended to. The muscular fibres are then cleanly cut through,† and the bluish-grey cartilage which caps the swelling now comes into view.‡ Any muscular branches being now carefully secured, and the wound sponged dry, the cut vastus is pulled aside with retractors, and the growth being thoroughly exposed it is shaved off with an osteotome or chisel, leaving exposed cancellous tissue. A little iodoform is dusted in, and needful drainage provided by a tube or large horsehair drain, passed from the wound to the most dependent spot on the inner side, the dressing-forceps passing under the muscle and being cut down upon by counter-puncture, where they project under the skin. The muscular fibres are then united with chromic gut, cut short, and the wound closed with separate sutures. Strict aseptic precautions are taken throughout to secure primary union. The limb should be kept absolutely quiet on a back splint, and a Martin's bandage worn, later, for a short time.

* This account will serve for the removal of other exostoses—*e.g.*, those met with at the deltoid insertion, the spine of the scapula, or the pelvis.

† This is more likely to conduce to primary union than tearing them through with a director.

‡ Any synovia-like fluid now escaping comes probably from a bursa over the growth, not from the joint.

UNUNITED FRACTURE OF THE FEMUR.

The large number of failures after operations for this condition are well known. The difficulties which may be present during and after these operations are very considerable; amongst them sufficient exposure of the fragments, keeping the wound aseptic, and the parts in correct apposition afterwards (*vide infra*), are most prominent.

Operation.—On the whole, the introduction of pegs having been less successful, sub-periosteal resection of the fragments is indicated here.* This is especially so in long-standing cases, where other methods have failed, where there is very little attempt at repair, where an artificial joint exists, or where, after a severe injury, necrosis, atrophy of the fragments, and fibrous union have followed.

The operation of resection should always be performed with strict aseptic precautions, otherwise the risks of suppuration, erysipelas, osteo-myelitis, and pyæmia, owing to the very free incision required, the exposure of cancellous tissue, and, perhaps, of the medullary canal, are considerable.

The following most important preliminary points are given by Mr. Treves (*Oper. Surg.*, vol. i. p. 588). “(1) It will be well in some cases to apply extension for a week or two before the operation, this overcomes the shortening produced by contracted muscles, and enables the surgeon to make trial of the splint he proposes to employ afterwards. (2) Before undertaking this operation the surgeon should understand that its success depends more upon the completeness of the arrangements that are made for keeping the bones in position after the operation than upon the operation itself, provided the latter be carried out with due care. . . . Care in the adjusting of the fragments, and infinite and continued care in the after-treatment, are the main elements of success in the present class of case. (3) In dealing with a fracture of the femur in an adult, it is well that the operation be performed as the patient lies upon the bed he will occupy throughout the whole treatment. Much moving of the patient after the operation is very undesirable, and a long thigh splint without extension apparatus cannot be conveniently applied upon the operation table.” The limb having been rendered bloodless, if practicable, with Esmarch’s bandages,† the fracture is exposed by a free incision, 5 to 6 inches long, on the outer side of, and going down to, the bone. The periosteum is next most carefully detached from the ends of the fragments, and a thin layer of bone, about a $\frac{1}{4}$ inch in thickness, removed from each. To facilitate the resection, the fragments may be thrust out of the wound, or, after the removal of the periosteum, dragged out and steadied with sequester-forceps before the saw is applied. The soft parts must be protected with spatulæ and retractors while the ends of the bone are removed with a narrow-bladed saw. The fragments are now brought into exact apposition, and to facilitate this it may be necessary to divide adhesions or

* Sir J. Lister has recorded (*Brit. Med. Journ.*, August 26, 1871) the case of an ununited extra-capsular fracture of the femur in a man, aged forty-five, where, eighteen months after the injury, he cut down on the fragments, with antiseptic precautions, and gouged them, the fracture being then finally put up. Recovery was complete, the man walking well.

† This step is condemned by some, notably by Mr. Treves (*loc. supra cit.*, p. 588). I admit that it leads to much oozing from the cut surfaces, but, having tried both ways, I am of opinion that this can be safely met by applying ample well-adjusted dressings before the bandage is removed, and that the advantage of a bloodless wound during a most difficult and prolonged operation is almost incalculable.

tendons, or to remove any intervening fibrous or fibro-cartilaginous material, or a sequestrum. If the fragments are successfully adjusted and carefully kept so (*vide supra*), the use of wire, pegs, and screws may be dispensed with. Their use prolongs and complicates the operation, and may give considerable trouble later on. If it be determined to make use of wire the ends are now to be drilled, the drill being entered on the superficial surface of each fragment, and then made to project in the centre of the medullary canal. They are next held together by passing very stout * silver wire through the drill-holes, and twisting this up. If the wire is to be removed three or four half-twists or two complete twists should be sufficient. If the surgeon prefer he may hammer it down, *in situ*, having made three half-twists and cut the ends short. See the remarks, p. 1206. Other methods that may be found superior to wire are Mr. W. A. Lane's screws (*Clin. Soc. Trans.*, 1894) and Prof. Senn's hollow perforated bone-cylinders or ferrules. These are circular or triangular and large enough to slip easily over the fragments. The most accessible fragment having been sufficiently isolated, the ferrule is slipped over it and far enough away from the line of fracture to clear the other fragment. After reduction has been accomplished, the second fragment is engaged in the ring, which is then pushed back sufficiently far to grasp both fragments securely. If the ferrule rides too loosely, any space should be packed with chips of decalcified bone. The limb is put up in plaster of Paris. If suppuration occur the ferrules are then removed by cutting through one side of it with bone forceps, by enlarging the sinus, when the parts are consolidated. If there is no suppuration the ferrule will probably be absorbed (*Ann. of Surg.*, vol. ii. 1893, p. 125). Sutures are best dispensed with so as to allow of free drainage. The after-treatment is that of a compound fracture.

* About $\frac{1}{16}$ inch in thickness, so as to withstand the strain of the muscles of an adult thigh.

CHAPTER IV.

OPERATIONS INVOLVING THE KNEE-JOINT.

AMPUTATION THROUGH THE KNEE-JOINT.—EXCISION OF THE KNEE-JOINT.—ARTHRECTOMY OF THE KNEE-JOINT.—WIRING THE PATELLA.—REMOVAL OF LOOSE CARTILAGES FROM THE KNEE-JOINT.—SLIPPED FIBRO-CARTILAGES.

AMPUTATION THROUGH THE KNEE-JOINT (Fig. 344).

Chief Methods.

I. By Lateral Flaps. II. By Long Anterior and Short Posterior Flaps.—Of these the first is far the superior. The great objection to the second is, that in order to get sufficient covering to fall readily over the large condyles, a long anterior flap must be cut; as this must reach 2 inches below the tibial tubercle, a good deal of its blood-supply comes from below—*e.g.*, the recurrent tibial must be cut off and the flap is thus liable to slough. This risk is much diminished, and the blood-supply better equalized, by the method of lateral flaps.

I. Amputation by Lateral Flaps.—This, the method of Dr. Stephen Smith,* was brought before English surgeons by Mr. Bryant.† The femoral having been controlled, the limb supported over the edge of the table, and slightly flexed, the surgeon standing on the right side of either limb marks out two broad lateral flaps as follows: His left index finger and thumb being placed, the former over the centre of the head of the tibia, the latter at the corresponding point behind, opposite the centre of the joint, he marks out (in the case of the right limb) an inner flap by an incision which, commencing close to the thumb, is carried down along the back of the limb for about $3\frac{1}{2}$ inches, and then curves upwards and forwards across the inner aspect of the leg, till it ends in front just below the index finger.‡ The knife not being taken off, a similar flap is then shaped from the outer side, but in the reverse direction. Dr. S. Smith calls attention to the following points: In making these flaps, they should be cut broad enough to secure ample covering for the condyles, and the

* *New York Journ. of Med.*, Sept. 1852; *Amer. Journ. Med. Sci.*, Jan. 1870.

† *Med.-Chir. Trans.*, vol. lxi. p. 163.

‡ Dr. S. Smith begins his incision about 1 inch below the tubercle of the tibia, and carries it up rather higher behind—*viz.*, to the centre of the articulation. It will be found easier to open the joint and to detach the semilunar cartilages from the tibia by making the incision as recommended above.

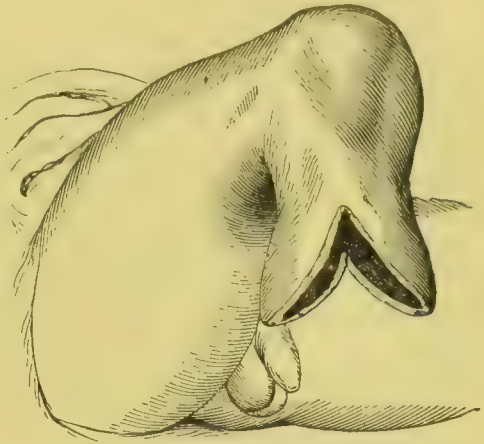
inner one should be made additionally full as the internal condyle is longer than the external. The flaps should be at least $3\frac{1}{2}$ inches long, if of equal length. They consist of skin and fasciæ. When they have been raised as far as the line of the articulation the ligamentum patellæ is severed, allowing the patella to go upwards. The soft parts around the joint are then cut through with a circular sweep, and the leg removed. In doing this, the limb being flexed to relax the parts and facilitate opening the joint, the semilunar cartilages will very likely be found closely encircling the condyles of the femur. Mr. Bryant, in the paper already quoted, and Dr. Brinton (*Philad. Med. Times*, Dec. 28, 1872), as long ago as 1872, have strongly advised that the semilunar cartilages should be left *in situ* by severing the coronary ligaments which tie them to the tibia. They thus, in Dr. Brinton's words, form "a cap, fitted on the end of the femur, which preserves all the fascial relations, effectually prevents retraction, and guards against the projection of the condyles." This precaution will obviate a serious objection to amputation through the knee-joint. For a time the patient bears his weight well on the end of the stump. But after some months the ends of the condyles (if unprotected by the menisci) begin to fret the thin overlying skin, and within a year of the amputation the patient, usually, has to have his artificial limb altered.

Mr. Pick's (*Med. Soc. Proc.*, 1884, vol. vii. p. 134) modification of the above operation is twofold—viz., (1) He begins his incision higher up—*i.e.*, at the upper border of the patella; and (2) he removes the patella. This last would appear likely to run the risk of damaging the blood-supply.

II. By a Long Anterior and a Short Posterior Flap.—The position of the patient and the surgeon being as at p. 1079, the latter with his left index and thumb on either side of the interval between the femur and tibia, enters his knife (in the case of the right limb) just below the finger and internal condyle, carries it straight down along the inner side of the leg till it reaches a spot 2 inches below the tibial tubercle,* then squarely across the leg till it reaches a corresponding point well back upon the outer side, and thence up to a point just below his thumb, or to the external condyle. This flap is then dissected up, containing the patella, as thickly as possible, and almost rectangular in shape, anything like pointing of its lower end being most carefully avoided, as certain to lead to sloughing.

This flap being raised, a posterior flap is made about two-thirds the length of the first, as at p. 1178, either by dissection from without inwards, or by transfixion after disarticulation.

FIG. 344.



Amputation through knee-joint by lateral flaps. The incision has been begun unusually low down. (Bryant.)

* Mr. Pollock (*Med.-Chir. Trans.*, vol. liii. p. 20) advises that the anterior flap should reach "quite 5 inches below the patella." It is difficult to see how sloughing can be avoided here, so much of the blood to this very long flap coming from below and being, of necessity, cut off.

EXCISION* OF THE KNEE-JOINT.

(Figs. 345-352).

Indications.—A. FOR DISEASE. B. INJURY.

A. (i) Pulp. Tubercular knee.

This condition, being the most frequent indication for excision of the knee, calls for most careful consideration of the following points:

(1) *Safety and Amount of Risk.*—Sir J. Lister's treatment, by removing sepsis, has rendered excision of the knee practically safe in properly selected cases. No surgeon who is familiar with careful antiseptic treatment and excision of the knee will say that the above is too strong a statement.† Excision here contrasts very sharply with the same operation at the hip, from the much greater facilities for getting away all the disease at the time, and for getting at and examining the wound later, together with the greater ease with which the wound here is kept aseptic.

(2) *Age.*—Here the operation has to be considered—(a) as a substitute for amputation; (b) as a substitute for the expectant treatment. While excision may be successfully employed at any age up to thirty, and even occasionally in older‡ patients, I consider the most favourable years to be from about fifteen to twenty. Before fifteen, and particularly before ten, we have especially to consider the effect of the operation on the growth of the bone; after twenty we have more and more to consider the condition of the patient, the state of the viscera, general vitality, &c. I would ask my reader's careful attention to these points—(1) that the chief growth of the femur takes place at its lower end (p. 1145); (2) that by fifteen, and still more by seventeen, the growth of the bone is largely completed. It follows from the above remarks that in young subjects, especially before ten, as little of the bones as possible should be removed, and that gouging should largely replace the saw (p. 1196).

(3) *Rank of Life.*—Excision of the knee being almost unknown in private practice, it is needless to remark that this

* This operation is contrasted with arthrectomy of the knee at p. 1021.

† I may perhaps here say that I have excised the knee seventy-seven times, and performed arthrectomy on eighteen occasions. Of the cases of excision four died of effects of the operation, one (mentioned below) from shock, another (also mentioned below) from threatening gangrene, a third from surgical scarlet fever, and the fourth from septicæmia. The child with surgical scarlet fever was moved, during my absence from town, into an empty, chilly ward; the eruption became dusky and then suppressed; coma, followed by death, ensued. Six have been submitted to amputation, making good recoveries. This number would probably have been seven, as a patient, aged fifty-three, whose knee had been excised for disorganisation after osteo-arthritis and whom I had advised to submit to amputation, went out able to walk a little with a stick, but with two sinuses.

‡ See the remarks on osteo-arthritis (p. 1187).

account of the operation refers almost entirely to hospital patients. Let me briefly, though imperfectly, depict the usual fate of these patients with pulpy knee *if not excised early*. Bandied about from one out-patient room to another, treated more or less imperfectly with splints and strapping, frequently recommended for admission that they may obtain that "rest" which can nowhere else be carried out, at last the "dresser for the week," or surgeon, takes pity on the case and it is admitted. With what result? As soon as the inflammation has subsided and the pain has ceased, the child is thought to be occupying a bed which can be better employed for clinical teaching, and, after a few weeks' rest in bed, is turned out again, perhaps in plaster-of-Paris or a Thomas's splint. A little later, in the rough-and-tumble life of the courts and alleys of our large towns, the joint is wrenched, and the good gained is all undone. Suppuration now sets in at one or more points of the pulpy tissue, sinuses form, the ends of the bone become carious, and the condition of the joint from the now advanced stage of the disease, and its probably septic condition, is rendered far less favourable for any operation than it was at an earlier stage. To speak briefly, believing, as I do, that in this rank of life excision will be needed in nine cases out of ten, I am of opinion, most distinctly, that, as soon as a pulpy condition is declared, excision or erasion (or, if needed, both combined) should be performed while the state of the joint and the general condition of the patient are, alike, favourable.

If the surgeon desires to have a time-limit at which it is justifiable to resort to excision he may remember the dictum of Mr. Howse (*Guy's Hosp. Reports*, 1894): "When a well-marked case of pulpy disease has lasted over six months, it is not worth while to attempt the conservation of the joint for a longer period." Under these conditions "we best consult the patient's interests by excising the joint on these grounds: (1) That the chances are very much in favour of the continued progress of the disease; (2) That even if the disease does not progress it will leave a damaged weakened joint, very liable to outbreaks of trouble; (3) That by means of the operation the duration of the treatment is so very much shortened, reducing to a few months what would otherwise take as many years; (4) And, finally, because by means of it, we greatly reduce the risk of tubercular infection, which results from the absorption of caseating products."

(4) *Value of the Limb*.—This *questio recata* of thirty years ago is now largely settled. Very few will, nowadays, be found to dispute which is most serviceable, a limb, though much shortened, with a natural foot, or an artificial leg, especially of the kind supplied to hospital-patients after amputation of the thigh. On this subject some remarks of Mr. Holmes (*Surg. Dis. of Children*, p. 497) may be quoted: "Even if we allowed that a patient, after successful excision of the knee, could only walk as fast and as far as some with a good artificial limb after amputation, this

would still leave the operation of excision, in my mind, far the superior one, since the former patient can do by his own force, without any preparation and without any expense, what the latter can only do by the aid of the instrument-maker. I need hardly say, however, that this is a gross understating of the case. A patient after excision of the knee can often walk nearly as fast and nearly as far as he could before. The patient after amputation of the thigh, however well the case may have done, can rarely bear the fatigue of carrying the artificial limb many miles together, nor can there be any reasonable comparison of the agility of the two—at least in those cases where the foot, after excision, comes nearly on to the ground, and is in good position." As to those cases where the limb is flail-like and its growth seriously arrested, I would point out that they should hardly ever occur, with the improved treatment of wounds, the greater facilities with which a stiff apparatus of a simple kind can nowadays be supplied, our more exact knowledge of the epiphyses, and the substitutes for the saw which are ready to our hands in the shape of sharp spoons (pp. 1190, 1196). I may also refer my readers to Sir W. Fergusson's *Hunterian Lectures*, Lecture VI., and his arguments in favour of a much-shortened limb over any artificial one.*

(5) *Condition of the Patient*.—I may refer my readers to the remarks on this point on excision of the hip, p. 1145. There is the same need here for examining for any evidence of lardaceous disease, or tubercular mischief, elsewhere, and to remember how latent and insidious these may be. Bone mischief elsewhere is not necessarily prohibitive. Three out of my seventy-seven cases (p. 1184) had had spinal disease, well-marked bosses remaining in all. Each of them made an excellent recovery. Strumous disease of the tarsus existed in two others, and was cured by the time the knee was well. In two, disease of the hip co-existed on the same side; in one the limb had eventually to be removed by a Furneaux Jordan's amputation, the child recovering; in the other (the disease being on the opposite side) the knee after a transpatellar excision did excellently, the hip disease being cured by rest.

(6) *Stage of the Disease*.—I have already shown (p. 1185) that I am a strong advocate for early excision in hospital cases, believing that, with the usual treatment, short of this, pulpy disease goes on, as a rule, inveterately from bad to worse. But in early life excellent results may be obtained, even in advanced cases with sinuses and caries, by excision, if only all the diseased and septic material is got away.

* Mr. H. Lee (*Lancet*, 1888, vol. i. p. 769) published the results, after twenty years, of two cases of excision in boys of twelve and seven. In the first the leg was 9 inches, in the second 6 inches shorter than its fellow. Both patients had perfect use of the muscles of the leg and foot, and could walk all day with a light iron patten attached to a boot. Such shortening is, nowadays, unknown.

It will be useful to some of my readers if, before leaving the subject of tubercular disease, I quote the opinion of one of the first living authorities on excision of the knee, Mr. Howse (*Guy's Hosp. Reports*, 1894): "In answer to the question, '**In what cases should excision be performed?**' we should say: (a) Certainly in all cases in which the disease has advanced so far as to cause flaking of the articular cartilage or grating in the movement of the joint, whether suppuration be present or no. (β) Cases in which backward displacement of the tibia has taken place. (γ) All cases of over six months' duration, in which there is reason to believe that the disease has started in an epiphysial osteitis. (δ) Cases of extensive suppuration in the joint starting from pulpy mischief. (ε) Cases in which the pulpy infiltration of the synovial membrane has advanced to any considerable degree over the articular cartilage. (ζ) Cases in which pulpy infiltration has extended beyond the capsular ligament to the crucial ligaments and semilunar cartilages." In the first four the condition and the need of excision are alike obvious. If in the last two difficulty of diagnosis arises, the time limit of six months (p. 1185) will be found of most value.

The same authority gives (*ibid.*) the conditions in cases of "**pulpy knee**" which call for immediate amputation. They are: A. Constitutional; and B. Local. A. Constitutional. (a) Lardaceous disease. (β) Tubercular disease of the lung or other viscus. (γ) Great emaciation without any very evident visceral disease. (δ) Multiple joint disease (*vide* p. 1186). B. Local. (a) Osteitis or periostitis extending far up the shafts of either femur or tibia, as shown by great thickness or tenderness of the bone.* (β) Very great infiltration of pulpy material into the soft parts, extending far beyond the limits of the joint.

(ii) Threatening disorganisation of the knee, with caries, after pyæmia, rheumatic fever, &c.

(iii) Osteo-arthritis.—Where one joint only is affected, and the patient is not past middle life, excision gives good results. The surgeon must be prepared for sawing very dense bones.

(iv) Ankylosis.—I think excision should be abandoned here for the far better operation of dividing, with aseptic precautions, the union, with an osteotome introduced first on one side and then on the other, and worked forwards under the patella, and skin, and backwards as far as the popliteal artery allows. If this fail, a double osteotomy of the femur and tibia should be performed rather than excision, an operation which, in the case of true bony ankylosis, is liable to be severe, prolonged, and to leave a large wound, and, in the case of young subjects, to lead to further shortening of a limb already atrophied and weakened from disease. As I shall not have space again to refer to this matter of ankylosis of the knee, I would strongly urge caution in rapidly and completely

* Mr. Howse points out that, occasionally, tenderness and thickening may be due to a sequestrum, which may be successfully removed, and later on a useful limb obtained by excision.

straightening a knee-joint which has long been the seat of a bony ankylosis in a bad position. My attention was drawn to this matter in a painful way about seven years ago. A girl of nineteen had been admitted under my care with bony ankylosis of the knee at a right angle, dating to disease seventeen years before. Finding that I was unable to materially improve the position by subcutaneously sawing through the bony union, I excised the joint and straightened it completely. The foot and leg remaining cold, an anæsthetic was given next day, and the limb put up flexed. The mischief was, however, done. The coldness remained, all pulsation in the tibials stopped, and gangrene evidently threatening, the thigh was amputated, the patient sinking afterwards.*

At the autopsy, osteophytes were found on the posterior border of the tibia projecting backwards, and it was evident that over these, when the limb was straightened, the popliteal vein, a very small one, had been stretched and closed. Another most serious risk of at once straightening a contracted knee is tetanus, from stretching of the contracted popliteal fascia and the popliteal nerves.

(v) Old, Neglected Infantile Paralysis.—Excision of the knee seems to me to be perfectly justifiable here, with a view of giving a firm support in the case of a limb useless from its flail-like, distorted state. I speak here of hospital cases, which furnish those miserably crippled lives which are still seen from time to time going the round of the hospitals.

I have lately been making use of operative measures largely in these cases, following, as far as the principle goes, my old friend, G. A. Wright, of Manchester, and Mr. R. Jones, of Liverpool. Every one who has seen much of these cases, with their dangling, flail-like limbs, going from hospital to hospital for courses of electricity and medicine, quickly out-growing or breaking expensive apparatus, obtained at much cost of time and trouble—any one who has taken the trouble of watching the after-history of these cases, and has realised how often they come, when adolescent, to amputation on account of persistent trophic sores appearing on the useless limb, must have wished that some operative steps could be devised which, at the cost of a few months, might make these early afflicted patients less of an encumbrance to others. The only question is what operation is best adapted to render the flail-like knee and ankle sufficiently firmly fixed to bear their share of the weight of the body. G. A. Wright (Abstracts of Cases treated in the Pendlebury Hospital, 1884) records the case of a girl aged

* Just after this another London surgeon published a very similar case. Sufficient attention has not been drawn to this matter. It would have been much wiser on my part, with such dense and old-standing ankylosis, not to have attempted complete straightening at once, but to have straightened partly with an osteotome at first, and then to have completely rectified the position later. I have adopted this mode successfully since, in a much older patient, with almost as much contraction.

fourteen, in which he excised the knee and ankle in such a case with good results. Mr. R. Jones (*Proc. Med. Journ.*, Dec. 1894 and Jan. 1895) recommends a modified erosion, opening the joint, peeling off all the cartilage in the case of the ankle, and, in addition, gouging the bone in that of the knee. While I agree with Mr. Jones that excision involves a greater sacrifice than an already shortened limb can spare, I maintain that by itself this operation is insufficient. If we are to do any good with these advanced and confirmed cases of infantile paralysis, we must replace, somehow, the flail-like limb by a useful firm support early in life, before puberty. Now, I have in several cases tried excision or erosion of knee and ankle and have found that in such a limb the joints do not unite firmly enough, the result, if watched, is not sufficiently good. The reason is not far to seek. In early life, if only small sections are removed with the saw—and no more is permissible for fear of further serious interference with the length and growth of the already dwarfed and dwindled limb—the bone surfaces are scant and puny, the rims of cartilage are, relatively, very large. Here the conditions needful for firm union are absent, and I have found excision or erosion alone of the knee and ankle does not entirely remove the flail-like condition of these joints. In two cases I have gone farther, and in addition to excising the knee I have passed Mr. W. A. Lane's screws between the tibia and fibula, and after all the cartilage has been removed from the surfaces of the tibia, fibula, and astragalus, have passed stout silver wire between the tibia and astragalus. These cases have been thus operated on about five months. The foreign bodies have, so far, given no trouble and the stability of the limbs is greatly improved. The time that has elapsed is not sufficient for one to speak confidently, but the result is certainly sufficiently encouraging for me to call the attention of my professional brethren to it.

B. INJURY.—Here such injuries as those from gunshot and those from a lacerated wound or a compound fracture, must be considered separately.

1. Gunshot.—“The results of the excisions of the knee-joint, performed during the late civil war, whether the operations were primary, intermediary, or secondary, were not very encouraging, forty-four of the fifty-four cases in which the issues were ascertained having terminated fatally, a mortality of 81·4 per cent., exceeding the mortality of the amputations of the thigh (53·8) by 27·6 per cent.” (Otis, *loc. supra cit.*, p. 419). Sir T. Longmore (*Syst. of Surg.*, vol. i. p. 565) lays down these definite rules: “From all the experience which has been gained regarding gunshot wounds in which the knee-joint has been opened, especially if the surfaces of the bone have escaped damage, as may occasionally happen with modern narrow rifle bullets, and even in other cases where one of the bones have been fissured, or partial fracture has occurred, provided early immobilization of the injured parts can be secured, antiseptic treatment carried out, and the general surroundings are sufficiently hygienic, it may now be laid down as a rule that conservative treatment ought to be adopted. When, however, the circumstances under which the wounds have been inflicted are such that the precautionary methods and modes of treatment mentioned cannot be put into practice, when the patients are liable to be moved frequently or to long distances

hurriedly, and without adequate protection, or when the joint is not only penetrated, but the surrounding coverings are much lacerated, or the bones are comminuted and the fragments completely detached, the sacrifice of the limb by amputation above the joint is the only measure calculated to afford a fair promise of safety of life to the patient."

2. Injuries other than Gunshot.—Excision is rarely practicable here. A very careful consideration of the local and general conditions present is needful. Amongst the former, damage limited to the articular surfaces, but little splintering of the shafts of the bones, an intact condition of the soft parts behind the joint are absolutely essential. Not less important is it to weigh the more general points connected with the patient—viz., his age not reckoned by years only, the condition of his viscera, and his habits; all these points are attended to in the account of "The Treatment of Compound Fractures," given later on.*

Operation.†—"The more I perform this operation, the more do I feel the truth of the words of Prof. Bruns, of Tübingen, that, while formerly its chief object was to remove all dead bone, it should now be considered of chief importance to remove all the tuberculous material that can possibly be got away, and that the surgeon should not content himself with snipping away all he can, leaving the rest to caseate or become scar-tissue if it will, but pursue it with the same earnest aim of extermination as he would in the case of malignant disease. I would not by the above seem to speak slightly of the value of securing healthy and correctly sawn surfaces of bone, as on these largely depends firm ankylosis and a sound and useful limb, but I would insist on the fact that such surfaces are secured in vain if pulpy material is allowed to remain, and that it is not as yet sufficiently recognised that other instruments—*e.g.*, sharp spoons and scissors curved on the flat—are, to the full, as useful as the saw.

Mr. Howse takes a different view of the importance of exterminating tubercular material (*loc. supra cit.*): "In thus advising the only partial removal of the pulp, it is necessary to recollect the changes of which it is capable. Many surgeons treat it as if it were a tumour formation, the success of the case depending upon its complete removal or destruction. This is, I am sure, a mistake. Pulpy material in its after-history is susceptible of three changes: (1) It may be simply absorbed, just as any inflammatory material disappears by the process of resolution; (2) it may undergo caseation by the process of starvation in the way already described; or (3) it may organise and become converted into good fibrous tissue." I can only say that with regard to the first and the third of the

* An interesting case has been published by Mr. Atkinson (*Brit. Med. Journ.*, 1883, vol. ii. p. 70) in which, eleven weeks after a separation of the lower epiphysis of the femur (simple) with displacement, excision was performed. The patient, a lad of fifteen, recovered, but the report is only carried up to two months after the operation.

† Before and throughout an excision of the knee the operator should bear in mind the following points: (1) To remove every atom of the disease: (2) to secure good drainage: (3) to leave the bones in good position: (4) to ensure absolute immobility afterwards: (5) to watch for and, at once, attack any relapse.

above, my experience has been much less happy than my colleague's; with the second or caseation we are all, of course, familiar wherever the tubercular material be met with. I repeat that, whether in glands in the neck or in the synovial membrane of joints, it should be treated once for all, if possible, thoroughly, determinately, and with the same earnest aim of extermination as in the case of malignant disease.

Before the time of the excision, any flexion of the knee should be corrected as far as possible by careful weight-extension. A knee should never be excised while flexed. Such a step will not only be liable to lead to removing bone needlessly in order to straighten it, but stretching the contracted deep fascia and nerves may lead to tetanus (p. 1188). The risk of gangrene has also been already mentioned (p. 1188).

The parts, having been duly cleansed, and an Esmarch's bandage* applied at mid-thigh, the limb† is brought over the edge of the table, flexed, and held by an assistant as in Fig. 347.

From the moment of commencing the operation to its very close the surgeon must bear in mind the inveteracy of tubercular pulpy material (malignancy would probably not be too strong a word), and in his endeavours to extirpate the disease completely, both in the soft parts and in the bones, his operation must often combine the operations of erosion and excision.‡

The following modes of exposing the joint will be given here :

A. Transverse, Removing the Patella. **B. Transverse, through the Patella.** **C. The Semilunar Flap** (lately recommended by Mr. Barker, and attributed by him to Moreau).

A. Transverse, Removing the Patella (Fig. 345). This, the older method, is still resorted to by those surgeons who, like Mr. Howse, believe that, if the patella is retained, a most serious risk is run of leaving behind pulpy material which will require removal later on under less favourable circumstances, and, this failing, may lead to amputation.

The surgeon, standing on the left § side of the diseased knee (the

* Some object to the bandage as needless and as likely to lead to troublesome oozing after the operation. This may be met by firm pressure and even bandaging on of the dressings, so as to distribute any oozing evenly throughout them. If an Esmarch's bandage is not applied, the bleeding during the operation interferes with the removal of diseased tissues, requires constant pressure to arrest it, and taxes the patient's resources considerably. Its use meets another risk, which is possibly hypothetical, and that is, it renders impossible the general diffusion of tubercular material by the cut veins and lymphatics. Two Esmarch's bandages must not be applied if there is any risk of rupturing a pulpy capsule, or where the capsule has given way and septic sinuses exist.

† Before the operation the area of incision should be thoroughly cleansed; the foot and lower leg should be well wrapped up in cotton wool, a heel-stirrup being applied if there is likely to be a sore heel. This is nailed to the foot-piece.

‡ If operations for pulpy knee are resorted to at an earlier stage in hospital patients, the bones will less and less need interfering with.

§ This position renders it much easier for him to saw the femur and tibia.

opposite limb being tied to the table), makes an incision right across the joint from the back of one condyle to that of the other.* This incision passes over the lower part of the patella and divides the lateral ligaments at once. The soft parts being then dissected up for 2 inches above the patella, so as to expose the supra-patellar

FIG. 345.

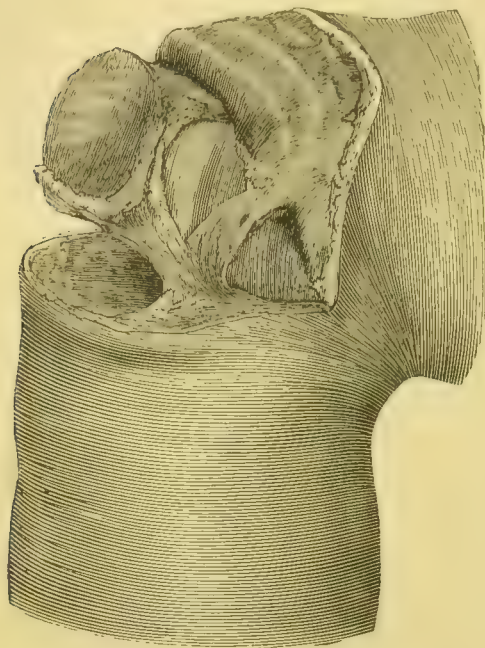
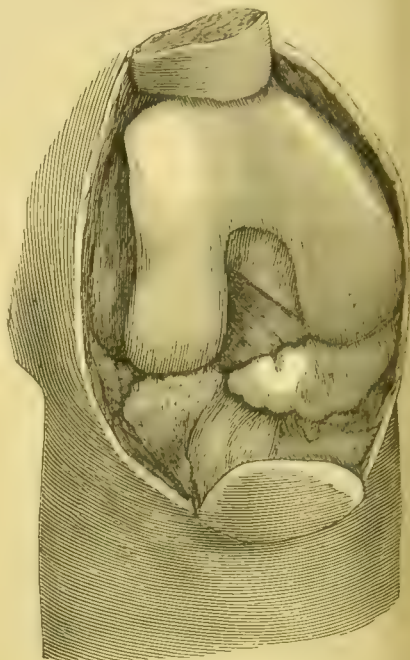


FIG. 346.



Trans-patellar excision.

pouch, deep incisions are made above and below the patella, which is then removed and the joint opened.†

If the patella is ankylosed to the condyles, it must be removed by a blunt elevator, aided by a narrow saw, or, better, by an osteotome and mallet. No violence should be used in opening a joint partially ankylosed, or the epiphyses may easily be separated from the shaft, especially in a child.

B. Transverse, through the Patella (Fig. 346).—This method, by preserving the patella and the insertion of the quadriceps, partly counterbalances the flexing action of the hamstrings (foot-note, p. 1199) at the same time. Used by Volkmann many years

* Beyond this spot the incision should not go, for fear of wounding the internal saphena vein. This would lead to troublesome œdema of the foot and leg, and, if the wound should become septic, might bring about septic phlebitis and pyæmia.

† I invariably, when raising the flap of soft parts in an excision of the knee, however performed, slit them up by a vertical incision, going to the upper limit of the supra-patellar pouch, so as to expose fully all its folds and recesses. Unless this is done, pulpy material is very easily left behind, and, later on, breaking down, leads to œdema, persistent sinuses, perforation of the pouch and escape of pulpy suppuration amongst the adductors and into the vicinity of the femoral, and perforating vessels where it is impossible to eradicate it, amputation being eventually called for.

ago, it was again brought under the notice of English surgeons by Mr. Golding Bird in a case which he brought before the Clinical Society (*Trans.*, vol. xvi. p. 82).

For arguments against preserving the patella I must refer my readers to Mr. Howse's article (*loc. supra cit.*). I am of opinion, myself, that in young subjects where the union is prone to bend for some time, it is well worth while to preserve the patella, though, to insure the full benefit of this step, fresh osseous surfaces should be prepared on this bone and on the femur and tibia so as to promote bony union. Another and minor argument in favour of preserving this bone is that the anastomoses about the joint are less interfered with.

The transverse incision is made here much as in the first method, only across the middle of the patella; this is sawn through or divided with a stout knife, the fragments turned up and down, and the joint freely opened (Fig. 346). To facilitate thorough cleaning out of the supra-patellar pouch, I always slit this up, as in the first case, by a vertical incision.

C. Semilunar Flap (Moreau, Barker).—Here a large U-shaped flap is raised by a semilunar incision, starting above one condyle, descending to the level of the tibial tubercle, crossing the leg here and running up to a corresponding point on the other side. In raising this flap, which includes all the soft parts down to the bone, either the ligamentum patellæ should be severed (suturing of this being resorted to later), or the tuberosity, attached to the ligament, is removed with a chisel, and subsequently wired down (Barker).

The joint having been opened by one of the above incisions, it is well to slit with a sharp bistoury the supra-patellar pouch* up to its upper limits (readily reached by a finger), so as to lay bare every crevice and to remove every atom of disease and tissue. The cut margins being held on the stretch by two Spencer Wells' forceps, the surgeon with mouse-toothed forceps seizes the cut edge of the synovial lining of the capsule and with curved scissors removes it in one piece first from under the vasti muscles and then along its reflexion on to the femur down to where it ceases at the margin of articular cartilage.

Next the lateral and crucial ligaments are examined, and every particle of diseased tissue removed, only bright, glistening, clearly healthy ligamentous tissue being left.† But as naked-eye examination in parts perhaps not absolutely bloodless may easily be fallacious, it is much better in doubtful cases to remove these completely than to run any risk whatever. The assistant who is in charge of the limb now brings the head of the tibia well into view

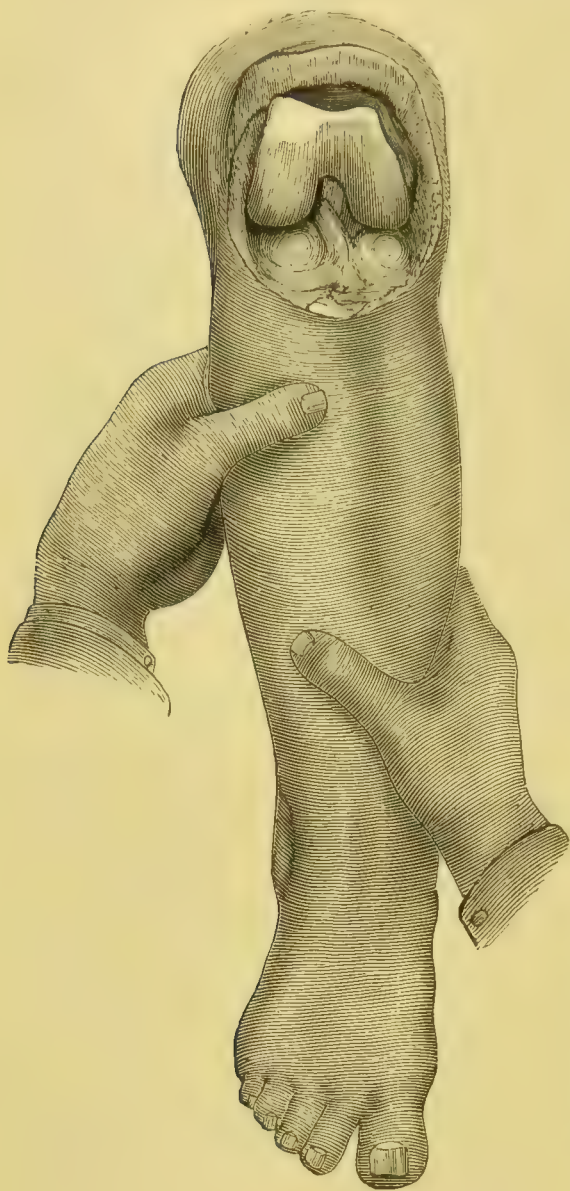
* I look on this as one of the most cardinal points of the operation.

† Prof. Ollier (*loc. infra cit.* and *Rev. de Chir.*, 1882) drew attention to preserving the lateral ligaments, if possible, together with all healthy periosteum and capsule—*i.e.*, those tissues which will keep the bones in place and which will tend to produce ossifying material. This will not interfere, if carefully carried out, with extirpating diseased parts, while it will go far to prevent progressive flexion of the joint.

by pulling the calf of the leg well forward with one hand while he further dislocates the bone by pushing up the leg (Fig. 347).

The condition of the semilunar cartilages is next examined, and if they are much invaded by pulpy tissue, or if it is intended to perform a complete excision, they must be cut away completely.

FIG. 347.



The back of the joint is next taken in hand. This region can be far more effectively dealt with after removal of the ends of the bones. If, owing to the case being an early one, with little or no caries, the surgeon desires to remain content with an erosion, he must still deal thoroughly with the posterior ligament* and deeper parts of the sides of the joint with all recesses and folds of the synovial membrane. To expose these parts thoroughly is a matter of some difficulty. The assistant should manipulate the limb as above directed at one time, at another flex the leg back towards the table, while occasionally a finger in the popliteal space will keep within reach any altered tissue that it is desired to deal with. Every pains must be taken to use the scissors systematic-

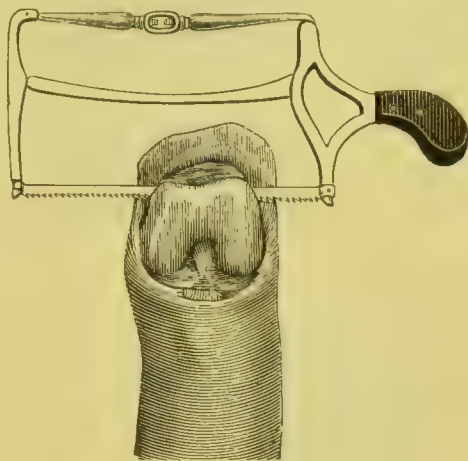
ally and thoroughly here as elsewhere, until healthy tissues are reached, and not to dread the popliteal artery too much. This should be enforced for two reasons. If any diseased tissues are left here, they will be shut in after the limb is extended and be impossible to deal with, save by a fresh and probably unsuccessful operation. Again, there is always a risk, especially in a surgeon's earlier operations, of his not dealing with disease here with suffi-

* This and the posterior parts of the semilunar fibro-cartilages are liable to be inefficiently treated.

cient thoroughness from dread of injuring the popliteal artery. This vessel may be avoided by (1) not dipping the points of the scissors deeply, but using the blades as far as possible parallel with the course of the vessel; (2) by remembering that even after the posterior crucial ligament has been thoroughly cleaned (a matter often imperfectly done) there is still a considerable thickness of structures in front of the artery.

After all diseased tissues at the back have been thoroughly eradicated, the deeper aspects of the sides of the joint must be examined. In one case I was unable to satisfy myself that the limits of the diseased tissues were reached till the tendons of the semi-tendinosus and semi-membranosus came into view; and in another, that of the sartorius, caseating foci having spread down beneath the fascia on the inner side of the joint. If an erosion is thought sufficient, the surgeon, having gone over the synovial membrane systematically and in detail, now attends to the bones. With a stout, sharp scalpel, he scrapes or pares off from the cartilaginous surfaces of femur and tibia any adherent pulpy material, removing thin shavings of the cartilage where needful. This must be carried out to the very back of the condyles and throughout the inter-condyloid notch, and around the posterior aspect of the head of the tibia.

FIG. 348.



It now remains to describe the removal of the bones in case erosion is not sufficient. Thus, excision will in future be probably called for only in cases of long standing, where caries is present, and in those with sinuses and suppuration. Where excision is evidently needed, the bones should be sawn after the supra-patellar pouch is cleared out, and before the posterior aspect of the joint is taken in hand, as this step will be much facilitated thereby.

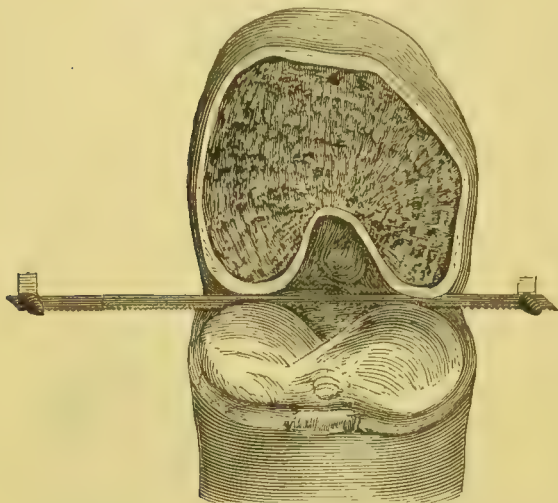
The femur, held as steady as possible, is taken first. A groove for the saw is first so marked out with the scalpel as to remove about one-third of the condyles. In severer cases, or where the above section will clearly be insufficient, half, or even two-thirds, of the articular surface may be removed, but no section should be made farther back than this, or the epiphysis will be trepanned upon with serious after-results.* The section of the femur should be

* Dr. Hoffa, of Wurzburg (*Arch. f. Klin. Chir.*, Band xxxii. Heft 4, 1885; *Annals of Surgery*, March 1886), brings forward cases to show that removal of both epiphyses led, at the end of ten years, to shortening, amounting to $25\frac{1}{2}$ cm. ($1\text{ cm.} = \frac{4}{10}\text{ inch}$), while in another case it amounted in two years to 10 cm. Loss of the femoral epiphysis alone showed 17 cm. of shortening in six years, and 7 cm.

made slightly from above downwards, and from behind forwards, so as to be parallel with the articular cartilage and at right angles with the shaft. Mr. Howse prefers to saw the femur while this is held vertically.

The tibia is taken next, and a groove marked out with the knife about $\frac{1}{2}$ inch below the articular cartilage. A Butcher's saw, set

FIG. 349.



horizontally, is used from behind forwards, and on a perfectly level plane. Neither here nor in sawing the femur must the slightest wobbling of the saw be permitted.

About $\frac{1}{2}$ inch only of the tibia should be removed, just enough in fact to expose healthy cancellous tissue, and no more. Of the femur, no more than $1\frac{1}{2}$ inch should be removed if possible.* Any soft, yellow, cheesy, fatty patches, any cancellous

tissue into which pulpy tissue has dipped after perforating the cartilage, should be carefully removed with a gouge. Where, however, there is much caries or the above patches are numerous, breaking down readily under the finger-nail, more than one slice of bone had better be removed.

The whole wound is now finally most carefully scrutinised, every outlying angle and recess being examined for pulpy tissue left behind.

The Esmarch's bandage is now by some removed, and while lint wrung out of 1 in 2000 hydr. perch. is held firmly over the sawn tibia, any bleeding points in the upper half of the wound are attended to. The safest way of arresting the bleeding is by underrunning with

in a year and a half. Two cases of the like duration affecting the tibial line showed respectively $15\frac{1}{2}$ and 6 cm. It is, however, well known that considerable shortening may occur in cases treated expectantly. Dr. Hoffa found in one case with ankylosis at an angle that at the end of twelve years the shortening amounted to 18 cm.; in nine other such cases, ranging in duration from one to eight years, the shortening varied from 1 to $13\frac{1}{2}$ cm., with angular contraction in most cases, and with very marked atrophy and trophic disturbances.

* Very much larger amounts may be removed if needful, especially in children and young adults, with good reparative power. If the surgeon is obliged to trench upon the epiphyses it should be with the gouge, and not with the saw, if possible. In one case of a boy, aged seven, the bones being carious, soft and fatty, a large patch of cheesy, fatty bone presented itself in the head of the tibia after the first slice had been removed. On removing this, the gouge entered the medullary canal, which was exposed, gaping on the sawn surface. I was doubtful how far union would take place here, but three years later the boy had a most useful limb, probably from a ring of epiphysial tissue being left.

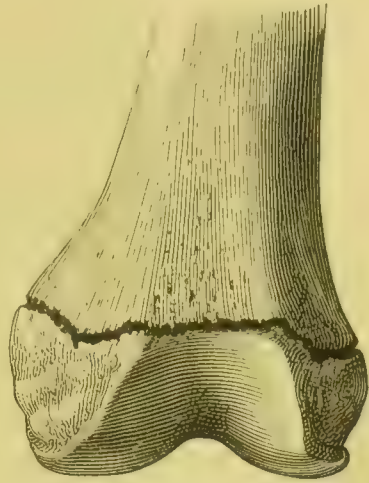
chromic gut and fine needles all the vessels which spirt, as practised by Mr. Howse; or Mr. Barker's plan (*vide infra*), which I greatly prefer, may be tried. Bleeding from the cancellous tissue will be arrested by placing the bones in contact.* If there is any tendency of the edges of the skin to fold in, these must be shortened.

The best means of arresting the hæmorrhage, and one which I have followed in all my later cases of excision and erosion, is that advised by Mr. Barker (Hunt. Lect., *supra cit.*). The Esmarch's bandage is here not removed until the dressings—a thick layer of iodoform gauze, sal-alembroth or salicylic wool, or wood wool—are firmly bandaged in position. To admit of sufficient pressure being applied to check the oozing and to distribute it evenly through the dressings, a white bandage should first be applied from the foot to the upper third of the leg. If one of Mr. Howse's splints is employed, the Esmarch's bandage must be applied sufficiently high up the thigh not to interfere with the limb being placed in the splint, as this has to be done before the dressings are applied. I have found this plan most satisfactory.

The patella, if sawn, is now drilled and wired, or united with stout silk or chromic gut. I prefer the first, the wire being left long and removed in about a fortnight.

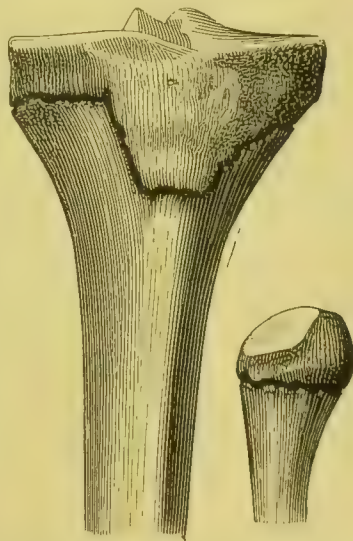
The question now arises whether the tibia and femur should be united by wiring or pegging.† I am of opinion that if the bones have been so sawn as to bring their faces squarely together, with sufficiently exact closeness to prevent more than a finger-nail being inserted between them, and if they are put up with the

FIG. 350.



This and the next figure shows the line of the epiphyses which enter into the knee-joint, seen from the front. That of the fibula is also seen. They are taken from a well-grown subject of about eighteen. (Farabeuf.)

FIG. 351.



* The following vessels will be found to give the chief trouble after a combined erosion and excision: One or two running down in the periosteum over the femur, one or two in the cut periosteum surrounding the sawn margin of the tibia, and one from the azygos articular in the posterior ligament.

† The bones have been united with different forms of pegs or nails, or by wire, stout carbolized silk, or chromic gut.

security which is given by Mr. Howse's method, the above aids are not needed.* Failure of excision is due not to deficiency of repair in the bones, but, as a rule, to persistency of pulpy, tubercular material.

The need of drainage must vary with the experience of the operator. If the bone surfaces are well together, and if the angles of the wound are left open, if aseptic precautions have been taken throughout, drainage is rarely required. Two or three sutures may be made use of in the middle of the incision, the sides being always left open. Before closing the wound, I dust a little iodoform, finely powdered, over the different surfaces, and dry these scrupulously, when the sutures are in place. Mr. Howse's splint is now applied. To those who are not familiar with the most excellent method devised by my colleague, the following brief account† may be useful. The arrangement will be found most simple, and equally efficient in admitting of antiseptic dressing and maintaining the parts in absolute rest. The splint consists of two interrupted tinned-iron troughs for the thigh and leg joined by a posterior bar. This is from 4 to 6 inches long, according to the age of the patient; it is convex from side to side to avoid cutting into the popliteal space, and can be lengthened or shortened if any alterations in the interruption are required. At the end of the splint is an adjustable foot-piece.

The limb being laid in the splint, attention must be paid to the posterior bar being in the centre of the popliteal space, the foot must be well down on the foot-piece; if the splint grips the thigh or leg too tightly or rides too loosely, it must be bent out or in with iron "crows." The dressings are now applied, preferably those of iodoform gauze, wrung out of carbolic-acid lotion, and wool. Great care must be taken to bandaging from below upwards and from within outwards, the bandage being laid on evenly and firmly so as to distribute the discharges, evenly, right through the dressings, and to prevent their coming through at one or two spots. The splint is next secured to the limb with "waxed bandages," prepared by passing them through a mixture of ordinary yellow wax and olive oil, in proportions sufficient to make the wax soft and workable. After they are applied to the leg and thigh they are painted over with a little hot wax mixture, so as to make them weld into one mass.‡ The limb, thus secured, is slung with cord

* I may be speaking with insufficient knowledge, but I am under a strong impression that the advocates of these aids have not made trial of the absolute fixity ensured by a well-applied Howse's splint (*vide infra*). Mr. Marrant Baker's and Mr. Howard Marsh's methods of fixing the bones by steel or bone pins will be found in the *Brit. Med. Journ.*, 1887, vol. i. pp. 321, 389.

† *Guy's Hosp. Reports*, 1877, vol. xxii. p. 503, and the accompanying plate.

‡ The splint is usually lined with lint wrung out of the above mixture. But the popliteal bar and any of the splint close to the wound must be metal only, uncovered, to favour asepsis. If any spaces are found to exist between the limb and the splint they may be filled in with cotton-wool, soaked in some of the hot wax mixture.

and pulley to Howse's modification of Salter's cradle. This occupies the lower part of the bed; the patient lies on a half water-bed.

The chief points now are (1) to ensure as absolute immobility as possible; (2) to employ as infrequent * dressings as practicable; (3) to watch for every sign of relapse, and to attack it as soon as noticed.†

After-treatment.—Morphia or laudanum should be used freely at first, if needful. If the temperature keep down, the dressings should be left undisturbed for two weeks, when an anæsthetic may be given, if needful, to remove the wire if the excision has been a trans-patellar one, take out any drainage-tubes, and also to make sure that there are no persistent sinuses pointing to residual pulpy material. These, if found, must be slit up with a sharp-pointed curved bistoury, and scraped out with a sharp spoon. While this may be repeated every two weeks, on five or six occasions successfully, the more deliberately the surgeon endeavours to extirpate the disease both in the soft parts and in the bones, the more he treats it as if malignant at first, the less often will he have to interfere later on (p. 1190).

In about three months, Mr. Howse's splint may be left off and a leather splint fitted on, carrying a metal bar to resist the tendency to flexion. Some such fixed apparatus should be worn, in children, for three or more years.‡

Causes of Failure and Death after Excision of the Knee.—

1. Inveterate persistence of pulpy material leading to (a) giving way of the supra-patellar pouch, and the results mentioned at p. 1192; (β) to formation of caseating foci, especially at the back of the joint (p. 1194), and only to be removed by re-excision or

* Infrequency of dressings has been strongly insisted on by Prof. Ollier (*Rev. de Chir.*, August 1887; *Annals of Surgery*, November 1887, p. 424). This most important economy—of pain to the patient, and time to the surgeon—is only to be secured by—(1) Removing every atom of the disease that can be got at. (2) Providing drainage. The more thoroughly the disease is extirpated, the less need is there to drain; but however completely the disease is removed, many sutures should not be employed, especially at the ends of the wound. (3) Securing as dry a wound as possible.

† It is especially, I think, from neglect of this last detail, that the fact arises that almost as many cases are lost from mistakes in the after-treatment as from want of skill in the operation.

‡ In early life callus-like material is thrown out quickly, and often somewhat irregularly, between the bones, but it is extremely slow in really ossifying. As the quadriceps extensor wastes much more quickly than the hamstrings, even when the patella is retained, the latter muscles keep up their action on the tibia for months, and even for years, until the union is firm. Tenotomy has been advised, and even resection of all the hamstring tendons (Dr. Phelps, *New York Med. Record*, July 21, 1886; *Annals of Surgery*, October 1886, p. 364). I think, however, that retaining the bones immobile and in good position, securing early healing of the wound, wearing a stiff apparatus, and, wherever practicable, using the trans-patellar method, will best ensure a limb soundly ankylosed in good position. A knee bent later on can be easily straightened.

amputation. 2. An unhealthy condition of the bone ends, with caries and chronic osteo-myelitis. 3. Deficient reparative power, leading to bed-sores, emaciation, irritative fever, hectic. 4. Co-existence or subsequent development of such visceral diseases as phthisis, &c. 5. Surgical scarlet fever. 6. Septic Conditions.—For these the surgeon will, nowadays, be, as a rule, entirely to blame. 7. Tetanus (p. 1188). 8. Secondary Hæmorrhage.—Another very rare condition. 9. Fat Embolism.—

FIG. 352.



A case of excision of both knees, two years after the operation, from a patient under my care at the Hospital for Children and Women, sent to me by Dr. A. T. F. Brown of Rochester. Both knees were the subject of tubercular disease on admission. One was excised three months after the other.

suppuration, no sinuses, nor evidence of as it was proved, tried to save the limb.

This is a still rarer condition, but one which, on account of the interest it excited some years ago, and because it has once, at least, proved fatal, deserves mention here.

The case was that of a child, aged twelve, submitted to excision for pulpy disease by Vogt, of Griefswald (*Cent. f. Chir.*, 1883, p. 24). The bones were so fatty as to cut with a knife. Though but little chloroform had been given, and the loss of blood had been slight, the patient died twenty-four hours later with shallow respirations, feeble pulse, and low temperature. Fat embolism of the lungs, extensively diffused, was found post mortem. Vogt considered that this case predisposed to fat embolism. Thus cut vessels were exposed on the sawn surfaces with plenty of free oily matter close by, and unable to escape, owing to the bone-ends being in close contact (two wire sutures were used). A similar case, after hip resection, by Prof. Lücke, is mentioned. Prof. Vogt thought that he would amputate in another case if, after excision of the knee, the limb could not be straightened without close apposition of the sawn fatty bone ends. 9. Shock.—This, though rare, must be remembered. Thirteen years ago I lost a case from this cause. The patient was a delicate boy, aged seven, with a large pulpy knee. As there was no much mischief in the bones, I, unwisely. The child sank a few hours afterwards.

Volkman (*Cent. f. Chir.*, Bd. xii. Heft 9, Feb. 28, 1885; *Ann. of Surg.*, May 1885, p. 486) draws attention to the need of taking care in children that too much blood is not lost, and that deep narcosis is not too prolonged.

ERASION* OF THE KNEE-JOINT.

Definition.—By this operation, which we owe to G. A. Wright,† of Manchester, is meant a systematic removal of the synovial membrane, which is, here, so often pulpy. If the ligaments are diseased, they are also removed; but if the bones and cartilage be involved, it must be only to a slight degree, so that all the disease can be got away by paring with a knife, or scraping out with a sharp spoon. Where sections of the bone have to be made, the operation becomes an excision as well as an erosion.

Value of Erosion as compared with Excision; Suitable and Unsuitable Cases.—Where a knee-joint the site of pulpy trouble resists, in hospital patients, non-operative treatment continued for three or four months; where there is no evidence of caseation in the joint (very difficult to tell, but indicated by chronic obstinacy of the disease, by spots where the feel is distinctly doughy or becoming bluish in tint)—in other words, where the disease is early, but, owing to the patient's surroundings, will go on from bad to worse, erosion is preferable to excision. Its *advantages* are,

* *Lancet*, 1881, vol. ii. p. 992; *Med. Chron.*, July 1885. See also a paper by Mr. Shield (*Ann. of Surg.*, Feb. 1888), and one by Mr. E. Owen (*Med.-Chir. Trans.*, vol. lxxii. p. 56). The following are Mr. Wright's conclusions: "In those that have done well the common factors appear to be: (1) absence or very small amount of suppuration; (2) superficial or, at least, not wide-spread bone disease; (3) absence of general tuberculosis. In short, fairly early disease in a not hopelessly tuberculous child. This pretty well corresponds to the cases generally considered suitable for excision. I have not yet tried the operation in adults. It is clear that extensive disease of bone and much suppuration will not allow good results to be obtained by erosion; neither, as a general rule, will they by excision, though I am quite sure that the knee may be successfully excised in cases where erosion is out of the question, as shown by excision succeeding where erosion has failed. Although in one case a freely movable joint resulted, I do not advise the attempt to obtain mobility by early passive movement, except in a few instances where the wound has healed at once, and there is no obstacle in the way such as dense and lowly vitalised cicatricial tissue. Erosion, if it fails, leaves the limb little, if at all, in worse condition for excision afterwards. In those cases where amputation became necessary, either the local or constitutional condition forbade hope of successful excision. Where it succeeds, erosion leaves as sound a limb as excision, without shortening. In some cases there may be mobility, though I think in most it will be found that there is not enough mobility to be useful; here the limb is very liable to become flexed after healing of the wound, but the same is true of excision in children. I think, then, that in suitable cases erosion is, in disease of the knee, better surgery than excision, but its application is strictly limited. In all cases I have employed strictly Listerian antiseptics."

† Arthrectomy was a term introduced by Volkman (*Cent. f. Chir.*, 1888), it is less accurate, and, etymologically, comes too near to excision.

(1) There is no removal of bone-slices, and, still less, any interference with the epiphyses. Thus, there is no shortening and no arrest of growth. This latter advantage will be at once recognized, when it is remembered that (p. 1145) the increase in length of the femur takes place chiefly at the junction of its shaft with the lower epiphysis, and in the case of the tibia at its upper epiphysis. In one of my cases, a girl of eleven, there was not only no shortening, but repeated careful measurements showed $\frac{1}{2}$ an inch increase of length, perhaps due to the increase of vascularity after the operation, about the above-mentioned epiphyses. (2) With regard to the retention of mobility, the frequency with which this has been obtained and its advantage have been, in my opinion, much exaggerated. I have no doubt whatever that a larger number of carefully published cases will show that where movement is sought for, the risk is run of a certain degree of permanent flexion and often troublesome sinuses. I should strongly dissuade from any attempt to secure mobility in the case of the knee and ankle. (3) The ligaments are less interfered with, and thus, the ties of the joint being preserved, firm union is more speedy. (4) If performed early, erosion, like excision, cuts short the disease, and thus gives a considerable saving of time in children, at an age when every month is of great importance. (5) It is better suited to young children. Thus, as it does not arrest development, it may be used very early. Wright has operated "with perfect success in a child under two years of age."

The *disadvantage* of erosion—I am speaking only from an experience of eighteen cases—is, I think, chiefly this, that if the operation fail, excision is rendered much more difficult. I cannot here at all agree with the statement of my old friend, the chief authority on this subject, that erosion, if it fail, leaves the limb little, if at all, in worse condition for excision afterwards. This is true of the limb, but not of the joint. In one of my erosions which required excision, I found that the previous operation had entirely obliterated the usual landmarks, and that great difficulty was experienced and much care needed in dealing with such parts as the remains of the posterior ligament.

The *cases suitable for erosion* are those where the disease is limited, or almost limited, to the synovial membrane, with little, if any, caseation; where the cartilage and bones are almost intact, where there are no abscesses or sinuses, where there is no evidence of other tubercular disease, and where the power of repair is satisfactory.

Operation.—The preliminaries are the same as for excision (p. 1191). A trans-patellar incision (Fig. 346, p. 1192) should be employed. But to ensure thorough exposure of the suprapatellar region, a very dangerous area on account of its numerous nooks and crannies which give lurking-places to pulpy mischief, I always slit this pouch right up to its very top with a sharp-pointed bistoury, thus dividing the upper flap into two. G. A. Wright ensures the same end by making

"longitudinal incisions through the tissues on each side of both halves of the patella, upwards as far as the upper limit of the synovial pouch, and downwards nearly to the tubercle of the patella." The flaps being then, one by one, thoroughly everted with a sharp hook, taking the upper half of the joint first, I seize the tip of one of the flaps with mouse-tooth forceps, and then with blunt-pointed scissors curved on the flat dissect the diseased synovial membrane off the under surface of the split quadriceps expansion in a continuous strip till the uppermost limit of the supra-patellar pouch is reached. The reflection of the synovial membrane over the front of the femur is then dealt with in the same way, leaving the periosteum on this quite clean. The joint being then well bent, and the tibia being brought forward as directed (p. 1194, Fig. 347), the crucial ligaments, the semilunar cartilages, the inter-condyloid notch, and the synovial reflections behind the crucial ligaments are carefully inspected. To do this thoroughly, it is absolutely needful to divide the lateral ligaments sufficiently. With regard to the other structures, some retain the semilunar cartilages if healthy, others remove them in any case. For my part, as it is so essential to remove *all* the synovial membrane, and this is impossible unless the semilunar cartilages go, I always remove them. With regard to the crucial ligaments, the anterior nearly always requires removal; the posterior, if clearly healthy and glistening, may remain. The inter-condyloid notch, and the reflection behind the crucial ligaments, is then taken in hand, very wide flexion of the joint, and a finger of an assistant in the popliteal space, here facilitating this, the most difficult and important part of the operation. When much disease is present here in the synovial membrane, both crucial ligaments must be unhesitatingly divided, and, if needful, the overhanging posterior part of the condyles must be cut away. In dealing with the synovial membrane in the inter-condyloid notch, the surgeon must remember that he will never have a similar chance of dealing with the disease here, and that, if any is left behind, excision, and perhaps amputation, will be called for. The synovial membrane around the lower half of the patella is then removed, and finally the ends of the bones are examined. Any pits and foci are gouged out, and more extensive ulceration shaved off with a strong sharp knife. Drainage, if needful (p. 1198), is then provided by making counter-punctures with a Lister's sinus-forceps in the popliteal space, on each side of the limb. The dressings are applied with the same precautions given at p. 1197, and not until all is completed is the Esmarch's bandage removed. Throughout the operation irrigation with lot. hydr. perch., 1 in 3000, should be diligently employed.

The after-treatment is the same as after excision (p. 1199); as there is the same tendency for a long while for the limb to become flexed, there is the same urgent need for a rigid apparatus for several years.

Causes of Failure after Erasion.—These are chiefly: (1) Some of the disease is left behind. This is known by a persistent sinus, and the liability of the limb to become puffy, hot, and tender. (2) Inability of the patient to repair the wound which is left. (3) Failure of the surgeon to maintain asepsis.

WIRING UNUNITED FRACTURES OF PATELLA.

This operation, brought before the profession by Sir J. Lister in 1883, seems to have dropped somewhat out of notice. This is perhaps due to two facts: (a) In the majority of cases a quite sufficiently good result is obtained by non-operative means.* (b) In spite of the vastly increased familiarity with antiseptic details, and their simplification, much of the old dread of opening the knee-joint still survives. The question was, however, sufficiently thrashed out to make it clear that the operation is justifiable under certain conditions. The indications may be stated somewhat thus:

1. In Sir J. Lister's words (*loc. supra cit.*), "no man is justified in performing such an operation, unless he can say with a clear conscience that he considers himself morally certain of avoiding the entrance of any septic mischief into the wound."

2. Certain Cases of Old Fracture of the Patella.—This important matter must be taken somewhat in detail. The chief points here justifying resort to wiring are: (a) Failure of previous treatment, especially in hospital patients. (b) A useless limb, especially in a man whose occupation entails much walking or standing, where the gait is helpless and requires much attention, or where many falls have followed involving serious risk of fracture on the opposite side. (c) Where both patellæ are fractured. (d) Where the patient is young and has many years of active life before him. (e) Where, if not young, the patient is sufficiently healthy. (f) Where enough is known of the patient's habits to ensure his being amenable.

3. Recent Fractures.—These must be considered separately, according as they are: (a) simple; or (b) compound. In the former case the general opinion of the profession has appeared to be against operation, owing to the good result which usually follows on non-operative measures. Prof. Lister's† five cases of wiring in recent fractures prove how safe this method is in skilled hands. (b) In compound fractures the matter seems to me to be different. Here a wound already exists, and, if the patient's condition is good, no harm can be done by wiring, with antiseptic precautions, any fragments which happen to be widely separated. Furthermore, such a step may be easily combined with the needful

* Mr. Ogier Ward (*Lancet*, November 1, 1884), in some interesting remarks on three cases—of which one was treated without, and the other two by, wiring—shows that in the first the total time lost before resuming work was twenty-seven weeks, and in the two wired, thirteen and eight weeks respectively; that the first case could not kneel before nine months, while the other two could do so six and five weeks after the operation. It will be seen that the loss of time was reduced by more than one-half.

† Sir Joseph goes so far as to consider (*Lancet*, November 3, 1883) that "the ununited case is in every respect worse as a subject of operation than the recent." This is chiefly owing to the wasting of the fragments and their greater separation. Again, in recent cases, there is no need to pare the fragments, for after sponging away of clots the surfaces are ready for coaptation.

examination and irrigation of the joint with dilute solution of mercury perchloride or carbolic acid, and the insufflation of iodoform.*

Operation.—The parts being thoroughly cleansed, an incision is made, with the strictest antiseptic precautions, including irrigation with hydr. perch., 1 in 4000, about $3\frac{1}{2}$ inches long, either vertically or transversely. The former is adopted by Sir J. Lister. The latter is the more convenient, and admits more readily of getting at the lateral aspects of the joint, if the aponeurosis above requires division at these points.† It is said to have the disadvantage of being more likely to give way and expose the joint if a refracture should take place later. I used it in four out of the five cases mentioned below, and think it well to make it rather above or below the interval between the fragments, so that this and the wound shall not lie opposite to each other.‡ The fragments when exposed§ are generally found embedded in fibrous tissue, thickened synovial membrane, and old decolorised coagulum. This must be snipped or cut away, and any spirting vessels in the thickened synovial membrane must be secured. A very thin section from each fragment is then removed with a narrow-bladed saw, this needing much caution in the case of the lower one, which is the smaller of the two. If the fragments can now be pressed into close apposition, nothing remains save to wire them, but the case is by no means so simple where the bones are widely apart. Thus, in one of my cases, after paring the fragments, these were quite $2\frac{1}{2}$ inches from each other, and after most forcible traction, the upper could only be made to descend $\frac{3}{4}$ inch. Malgaigne's hooks were now applied and tightly screwed up, but with no result on the desired approximation. The lateral expansions of the quadriceps were next still more fully divided (cut muscular fibres being seen on the inner side), but the fragments were almost as far apart as ever. As the only alternative to excising the joint (in order to substitute a firm support for the flail-like limb), I now divided partially the rectus tendon, but it was not till the upper fragment was only held by a narrow stout band at its upper and inner parts that it could be brought in apposition with the lower one. The result was excellent.

In these difficult cases it must be remembered that it is not absolutely necessary to get the fragments into exact apposition. If, after wiring, they come within $\frac{1}{4}$ inch of each other, the limb will be a most useful one, though of course exact apposition is to be desired.¶ When, in spite of all the above, approximation of the fragments is still impossible—though it is difficult to imagine such a contingency—the knee should be excised either now, or on another occasion, so as to give a firm support.

The fragments being sufficiently approximated, they are now drilled. This

* Dr. G. R. Fowler, of New York (*Annals of Surgery*, September 1885, p. 248), calls attention to the great importance of making these cases aseptic at the first. In his case the bone was split into three fragments. The two lower ones were first wired together, and their upper margins were next sutured to the upper fragment by two wire sutures, one for each lower fragment.

† It would also be probably more convenient in a compound fracture.

‡ An Esmarch's bandage is not needed, and would have the objections of causing oozing afterwards into the joint cavity, and also of preventing that bringing down of the extensors of the thigh which may be required in cases of wide separation.

§ In one case, the skin being dimpled, puckered down, and adherent between the fragments, I had to cut away a piece about $\frac{3}{4}$ inch in diameter.

¶ In a case of Mr. Wheelhouse's (*Brit. Med. Journ.*, June 9, 1883) the fragments, originally $1\frac{1}{2}$ inch apart, could only be brought within $\frac{1}{2}$ inch of each other; an excellent limb resulted.

may be easily effected by an ordinary bradawl, sterilised. The bones should be drilled obliquely, the instrument entering each fragment a full $\frac{1}{2}$ inch from the fracture on the upper surface, and emerging above the cartilaginous surface below.* Where the lower fragment is too small to hold a wire,† this may be passed through the ligamentum patellæ, as has been done by Sir J. Lister (*loc. supra cit.*) and Mr. Teale (*Brit. Med. Journ.*, June 9, 1883). One wire would appear to be sufficient: though this unites the centre of the fragments exactly, a very slight interval remains at the edges, but does not interfere with an excellent result.

When the wire is twisted, two half-twists, or one complete one, will be sufficient, and it should be noted at the time in which direction the twist is made, in case the wire is removed. This raises the question as to **the best way of dealing with the wire**, whether to cut it short and embed the ends by gently hammering them into the fibrous tissue over the upper fragment, or to leave the wire long enough to admit of its being removed later. I have alluded to this question at p. 80. Sir J. Lister advocates the former course. I shall not, I trust, be thought wanting in proper respect if I suggest that in the knee, at least in women who have much kneeling, removal of the wire will be more satisfactory. Thus, in one of my cases, in which I had hammered down the wire, the woman returned, nearly a year later, to have the wire removed. She had not been able to kneel, the suture could be felt, and at one spot the skin was ulcerating over it. I ought to state that the patient was a very thin one, and that I had made three or four half-twists instead of two.‡

Before the wire is twisted or hammered down, if this course is decided upon, the surgeon must decide as to **drainage** of the joint. When the operation has

* While it is well to take this last precaution, it probably does not matter much (supposing, of course, that strict antiseptic precautions are taken) if the wire is passed within the joint. Sir J. Lister gives the following aid to making the two drill-holes exactly correspond: "Supposing that on one side the instrument should have come too far down, it may be into the cartilage; we do not regard that at first, but pass the wire through the two drill-holes, and then on that side on which the hole has come too far down, by means of the bradawl we simply chip away a little of the material that is above the wire, until the wire comes to be in a position exactly opposite to the hole on the other side." If, in another case, there is difficulty in making the drill emerge upon the fractured surface, Sir Joseph would advise to withdraw the drill and substitute the blunt end of a needle, and then with a gouge or bradawl to excavate an opening upon the fractured surface, opposite to the other drill-hole, until the needle is exposed; the wire can then be easily passed.

† The most difficult fragment should be taken first. The wire is liable to hitch at two points—one in hitting off the drilled orifice in the second fragment; the other, as it comes up through the fibrous tissue covering this fragment.

‡ Prof. Macewen (*loc. infra cit.*) mentions a case which came under observation three months after suture of the patella, with acute suppurative arthritis of the joint and ulceration of the cartilage. A probe passed through a sinus detected the wire surrounded by carious bone. The twist was still intact, but the loop was loose, the bone having become inflamed, softened and ulcerated. Excision of the joint was required. This shows that, occasionally, the wire may excite irritation and thus lead to serious results. Mr. Turner (*Lancet*, 1887, vol. i. p. 572) records a case in which Mr. M. Robson, of Leeds, had wired an ununited fracture of the patella, three gold wires being employed. The patient, an epileptic, probably injured the knee repeatedly, the wires worked out, and the knee-joint became acutely inflamed, requiring free incisions and drainage.

been difficult, involving much separation of adhesions, and interference with the parts, drainage should be employed through the wound to the most dependent part of the joint at the outer side (Lister), thrusting the instrument here through the joint and soft parts, cutting upon it and drawing a drain through. The wound is then united and dressed. As soon as the deeper part of the wound is healed, every pains must be taken, by massage, &c., to improve the atrophy of the quadriceps. Healing should be complete in three weeks. If it be decided to remove the wire, this may be done six or eight weeks after the operation, by making a small incision through the scar. The number of half-twists and the direction in which they have been made must be recollected at this time. The wire is first untwisted and straightened, one end is next cut off short, and the other grasped in dressing-forceps, and wound round the tips of these. It is then extracted without jerking.

The question of passive movement now arises. Usually, about six or eight weeks after the operation, the patient may get up and begin to use the limb (with the aid of two sticks at first), flexion and extension being diligently practised. Unless the joint is very stiff, massage, friction, and gentle persevering movement, aided by time and patience, will be sufficient. If an anæsthetic is given, movements must be made cautiously, as the patella has been refractured on this occasion more than once.*

Difficulties in Wiring the Patella.

1. Atrophied surfaces of the fragments, making it difficult to refresh them satisfactorily. 2. A very small lower fragment. 3. Fragments embedded in very firm fibrous tissue, fascial, periosteal, and synovial, or old coagulum. This condition will prevent satisfactory apposition unless the intervening tissue be all removed. In a very interesting case recorded by Mr. O. Ward (*Lancet*, Nov. 1, 1884) it was found, on exploring the fragments, that the capsular tissues torn off the lower fragment remained attached above, and hung like a flap between the fractured surfaces, effectually preventing their apposition. It is suggested that some such complication may, in many cases which have been treated in the usual way, cause the fragments to fall apart as time goes on. This is supported by Prof. Macewen, *Lancet*, Nov. 17, 1883; *Ann. of Surg.*, March 1887, p. 178, who has collected thirteen cases of transverse fracture of the patella, in which portions of soft tissue intervened between the fragments in such a manner as to render osseous union an impossibility. 4. A contracted, rigid quadriceps. 5. Indipping skin, p. 1205. 6. Multiple fragments.—This may cause much difficulty, especially if it is the lower and usually smaller fragment which is comminuted. If the lowest fragment is large enough to bear wiring, a smaller one may be removed; or the wire may be passed through the ligamentum patellæ. If a case seemed to require it I should not hesitate to wire smaller fragments with finer wire, and to pass one stout one from the highest to the lowest fragment (or ligamentum patellæ), this wire lying in the joint, and passing under and over one of the smaller ones. To give a firm support excision could be resorted to as a last resort, either at the time or later.†

* In one of Sir J. Lister's cases (*loc. supra cit.*), passive movement being employed with "considerable force" four weeks after the wiring, the rigid quadriceps not yielding, the wire gave way, and the cicatrix (a long longitudinal one), which had healed save where the wire projected, opened. The joint was at once washed out antiseptically, and, six days later, some coagula were removed and the old wire retwisted. An excellent limb was the result.

† Mr. Mayo Robson brought the following method of securing bony union of the patella, without opening the knee-joint, before the Clinical Society (*Trans.*, vol. xxii. p. 286; *Brit. Med. Journ.*, 1889, vol. i. p. 1229). The parts being carefully purified, the joint aspirated, the skin over the upper fragment was drawn

Causes of Failure.—These are, mainly: 1. Inability to bring the Fragments together.—Mr Turner (*Clin. Soc. Trans.*, vol. xviii. p. 41) mentions a case in which the operation was abandoned, as it was found impossible to get the fragments together after wiring them. The patient was “no better and no worse” eventually. 2. Septic conditions. 3. Necrosis of a Fragment.—This is a complication rather than a cause of failure. It is especially likely to occur after severe compound fractures, in which the periosteum was much injured at the time of the accident. This happened with the upper fragment in Dr. G. R. Fowler’s case already quoted. About three months after the wiring, this fragment, about the size of a walnut, was removed. It was now found that “the joint was perfectly closed by a thick fibrous capsule underlying the necrosed portion, connected to the upper margins of the now firmly united two lower fragments, and forming a strong bond of union between the quadriceps above and what remained of the patella below.” The resulting limb was useful, with considerable movement at the knee-joint.

REMOVAL OF LOOSE BODIES* FROM THE KNEE-JOINT.

This is another instance of an operation rendered safe and simple by the antiseptic treatment of Sir J. Lister. Removal by **direct incision** will therefore be alone described here.

Operation.—The parts having been kept at rest for some days before and scrupulously cleansed, the foreign body is found,† if possible, and retained in a superficial part of the capsule. If it be very movable, it should be harpooned

up so as to avoid traction on the skin, and a pin was pushed from without inwards, through the quadriceps tendon immediately above the upper fragment, and made to project at a corresponding point on the opposite side of the knee. Another pin was in like manner pushed through the upper end of the ligamentum patellæ, just below the lower fragment. Gentle traction on the pins quite easily brought the fragments into contact, and a figure-of-eight suture of aseptic silk retained them in position. An antiseptic dressing was applied and not removed for three weeks, when the pins were removed. Bony union was secured.

* The following classification may be useful to a surgeon about to operate for one of these bodies: (1) A thickened or indurated synovial fringe which has become pedunculated and perhaps detached; (2) a fibro-enchondroma originating in those cartilage cells which are naturally found in the synovial fringes; (3) a portion of articular cartilage detached by injury (four years ago I removed one of these loose bodies from the knee-joint of a railway porter who came to me for synovitis, with the history that the attacks dated from the time when a cask which he was moving had slipped and struck the inner side of his right knee-joint—*Lancet*, 1889, vol. ii. p. 363); (4) a bit of cartilage may, after injury, gradually become detached by a process of quiet necrosis (Paget); (5) blood effused into a synovial fringe; (6) a mass of fibrine; (7) a detached osteophyte; (8) Mr. H. Marsh (*Dis. of Joints*, p. 182) mentions a case of Mr. Shaw’s, in which a loose body on removal was found to contain the point of a needle.

† The patient is often clever at this. Mr. H. Marsh (*loc. supra cit.*) suggests that it may save disappointment if fixing the body has been practised beforehand by the assistant to whom this office is to be entrusted. In those rare cases where the body cannot be found, no surgeon familiar with antiseptic details would hesitate to freely cut into the joint if the history and the crippling of the patient justified this. In other cases, as occasionally happens in lithotomy, the body is known to be present, but cannot be felt when the patient is on the table.

with a sterilised needle at the beginning of the operation. The joint is then deliberately and sufficiently opened. In the traumatic case I have mentioned, the body could not be felt at the time of the operation; on cutting freely into the joint I came down on a tiny pedunculated body attached to the deformed internal condyle; as this was evidently too small to be the offending body, I had, after removing it, to make a prolonged search with the finger before the loose cartilage was found at the extreme upper end of the supra-patellar pouch. In any such case where the body can be felt, but not brought down, a second incision should be made over it. Any bleeding is now finally arrested, and the wound closed by sutures which carefully take up the capsule. If the operation has been a simple one, no drainage will be required, effusion being prevented by aseptic precautions and firm, even bandaging. Where the search has been prolonged, the parts much interfered with, or many bodies removed, a horsehair drain or a small tube must be passed through the wound, and a counter-puncture at the most dependent part of the joint.

Iodoform having been dusted on, the usual dressings are applied, and the limb put up on a back splint.

INTERNAL DERANGEMENTS OF THE KNEE.— SLIPPED FIBRO-CARTILAGE.*

These affections are so crippling and vexatious that I shall allude to them here, though operative interference will be very rarely required if the case is treated by the proper apparatus (*vide infra*). The key-note to the satisfactory recognition of these injuries and their well-doing, is a recognition of the fact that one of the semilunar cartilages, usually the internal, may after a hurt or wrench of the joint be partially torn away from its marginal attachments, usually the anterior ones (Annandale-). In some cases the cartilage is split instead of displaced; in others it undergoes gradual enlargement in consequence of repeated injury and synovial irritation.* With regard to treatment, it should be distinctly understood that, after reduction, rest, counter-irritation, &c., the application of ordinary splints or knee-caps is not of the very slightest use; there is one instrument, and, as far as I know, one only, which will meet these cases, and do away in the great majority of cases with any need of operation, and that is the "knee-clamp" made by Spratt, Hawksley, &c., and figured by Mr. H. Marsh in his excellent account of this affection (*Dis. of the Joints*, pp. 212, 213). Having watched these clamps in many patients, I can testify most strongly to their value.

Operation.—Where the above clamps fail, or where other trouble is present, as in Prof. Annandale's and my cases; where the life is spoilt by the affection, and other conditions are satisfactory, opening the joint and removal or, much more rarely, suture of the cartilage, is justifiable. The skin having been carefully cleansed, and the strictest antiseptic precautions made use of, an incision, longitudinal as in the case mentioned below—a transverse gives more room but, I think, weakens the joint more—is made over the fibro-cartilage, for about 3 inches. All bleeding having been carefully arrested, the synovial membrane is incised, and hæmorrhage again stopped. The condition of the cartilage is then investi-

* Reference should be made on this subject to the following writings: Hey, *Pract. Observ. in Surg.*, 1803; Howard Marsh, *Dis. of the Joints*, p. 190; Annandale, *Brit. Med. J. ur.*, 1887, vol. i. p. 319; H. W. Allingham, *ibid.* 1888, vol. i. p. 1110, and *Treatment of Internal Derangements of Knee-Joint by Operation*.

gated, and, if displaced, it is drawn into position with a blunt hook, and sutured* with chromic catgut to the periosteum and fascia over the edge of the head of the tibia. If the cartilage cannot be thus brought into position, it should be removed, and the same should be done if a portion is found split off but still attached. Any growth that is present, whether fibro-fatty of the synovial membrane,† or an osteo-arthritis outgrowth from the bone (*vide infra*), should be removed by scissors, saw, &c. A few strands of horsehair are then inserted, and the synovial membrane carefully sutured with buried sutures of catgut. The skin incision is then closed with salmon-gut sutures. In about three weeks careful movements of the joint should be begun. The chief trouble in the after-treatment is obstinate stiffness.

The following are brief notes of the only case in which I have found it needful to remove a semilunar fibro-cartilage. It will be noticed that previous treatment had failed, and that osteo-arthritis was present to a marked degree in a young patient. R. C., aged thirty-five, had had repeated displacement of his left fibro-cartilage since a wrench of his knee when seventeen years old. A clamp gave great relief for some time, but latterly this ceased to be any safeguard. In April 1894, I opened the knee-joint by a vertical incision three inches long, placed about an inch from the inner margin of the patella, and beginning opposite its centre. The first thing to come into view when the joint was opened was the inner condyle with its margin converted into a huge lip, everted and raised and covered with a network of many minute vessels. The head of the tibia, as far as seen, presented the same appearance along its articular rim. The internal fibro-cartilage was found detached from its connections to the tibia and carried up with the femur. It was thin, flaccid, and limp, flattened out, its circumferential border having lost its thickness and convexity. No bleeding followed on snipping through its posterior attachments. The "lipping" of the cartilage on the femur and tibia was rounded off with a metacarpal saw, some sessile growths of the synovial membrane were snipped away, and two small osteophytes removed from the articular surface of the patella. The inner aspect of the joint was carefully dried out with aseptic sponges, and, as much oozing was expected from the sawn surfaces, a drainage-tube was passed into the upper cul-de-sac and brought out through the wound. The wound healed quickly; a month later the patient could walk across Hyde Park, but it was not till nearly six months after the operation that flexion and extension were completely restored, and the patient could say that there was "not much to choose between the two knees." I have seen him lately, two years after the operation; he can now use the lower limbs with equal freedom, and the movements of the left knee are quite smooth. He is able to walk, ride, and shoot, with entire comfort.

Another case which had been watched after the operation, before being reported, was brought by Mr. Lockwood before the Clinical Society (*Trans.*, vol. xxvii. p. 133; *Lancet*, 1894, vol. i. p. 673). Here twenty-one months had

* This step can rarely be advisable. It is difficult to get a secure hold for the sutures. Mr. M. Moullin (*Lancet*, 1895, vol. i. p. 1233) mentions two cases in which the displacement recurred after suture. In his words: "Sutures and adhesions cannot make it stronger than it was before it was hurt, unless they fit it so that it is completely rigid: and if it gave way before it will give way all the more easily a second time if exposed to a similar strain."

† In very rare cases, with the history and symptoms of displaced fibro-cartilage, the menisci are found *in situ*, and the only abnormality and cause of interference with the movements of the joint is a small mass of fibro-fatty tissue lying over the fibro-cartilage at the site of pain (Annandale, *Brit. Med. Journ.*, 1887, vol. i. p. 320).

elapsed since the operation. The left knee had, after an injury, been liable to become locked under circumstances which rendered the patient's occupation, that of an engineer, dangerous. Though nothing could be felt externally, when the joint was opened the internal fibro-cartilage was found to have its anterior third torn up from the tibia. This portion was cut away, and the remainder sewn down to the tibia with silk sutures. The patient made a rapid recovery, but neglecting the advice given, not to play tennis or football for a year, had synovitis with considerable effusion after taking violent exercise. Later on, he reported that for walking, riding, and swimming, the knee was as good as the other. Exercises involving any risk of twisting the joint he had avoided.

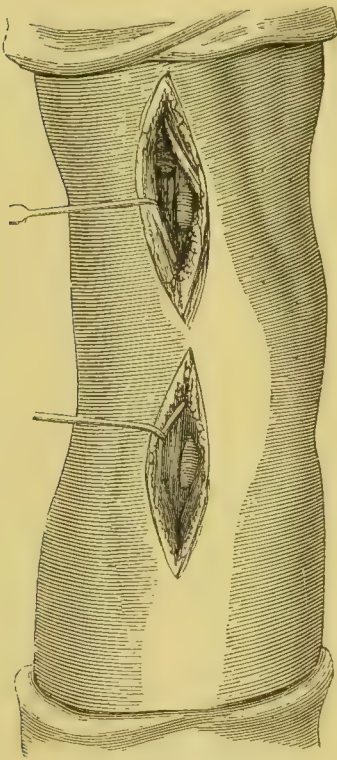
CHAPTER V.

OPERATIONS ON THE POPLITEAL SPACE.

LIGATURE OF THE POPLITEAL ARTERY.

Indications.—Extremely few. i. Stab or punctured wound.—Here the surgeon would only resort to ligature, (1) if pressure was unavailing; (2) if the

FIG. 353.



Above, the artery is shown under cover of the semi-membranosus. The small sciatic has been drawn aside with a blunt hook. Below, the vessel is exposed just above the heads of the gastrocnemius. The internal popliteal nerve is seen below outside the artery just before it crosses to the inner side.

tion for a ruptured popliteal aneurism, he should first consult a clinical lecture

patient insisted on running the risk of gangrene; (3) it would be well, if possible, to get leave for immediate amputation if the vein was found injured also. ii. In some cases of ruptured popliteal artery it will be right to explore and see if any other complication exists beyond the rupture of the artery.* If there is no injury to the vein, nerves or the joint (a very unlikely contingency), the rupture may be treated by double ligatures as elsewhere. The surgeon must afterwards be prepared to amputate through the lower third of the thigh on the first sign of gangrene appearing. The operation of ligature of the popliteal artery is extremely difficult here, owing to the depth of the vessel, the strong fascia, the amount of coagulated blood, and the infiltrated, obscured condition of the parts. Primary amputation will, as a rule, be required in cases of ruptured popliteal artery, especially where skilled assistance and facilities for antiseptic treatment are not at hand. A free incision will enable the surgeon to investigate the amount of injury, and at the same time will relieve tension if an attempt is made to relieve the limb. This incision may form part of the amputation (p. 1183). iii. The artery has been wounded in the course of an osteotomy of the lower end of the femur. In such a case the vessel should be reached by the incision given at Fig. 354. iv. "Possibly in a small traumatic aneurism" (Sir W. Mac Cormac, *Ligature of Arteries*, p. 109). If any surgeon is inclined to perform the old opera-

* Poland, *Guy's Hosp. Reports*, third series, vol. vi. p. 294.

on a case of this kind by Mr. Holmes. The difficulties which may be expected are graphically described, and the wisdom of amputation shown.

EXTENT.—From the adductor opening to the lower border of the popliteus.

GUIDES.—*Behind*: A line drawn from just inside the inner hamstrings above to the centre of the lower part of the popliteal space
In Front: The tendon of the adductor magnus.

RELATIONS (in the popliteal space):

IN FRONT.

Skin; fasciæ; small sciatic nerve above; short saphena vein and external saphena nerve below; fat; glands.

Semi-membranosus, above; gastrocnemius, plantaris, soleus, below.

Internal popliteal nerve; popliteal vein, outside above, inside below, exactly over the artery in the centre of the space.

Branch of obturator above.

OUTSIDE.

Biceps, above; gastrocnemius, and plantaris, below.

Popliteal artery.

INSIDE.

Semi-membranosus, above, gastrocnemius, below.

BEHIND.

Femur.

Posterior ligament.

Popliteus.

Collateral Circulation.

ABOVE.

Anastomotica magna, superior articular, descending branch of external circumflex.

with

BELOW.

Inferior articular, and recumbent from anterior tibial.

Operations (Figs. 353, 354).—The artery may be tied in three places. A. At the upper part of the popliteal space. B. At the lower part of the popliteal space. C. *From the front*, at the inner side of the limb. For the sake of experience, all should be practised on the dead body.

A. At the Upper Part of the Popliteal Space (Fig. 353).—The patient being rolled two-thirds on to his face, and the limb at first extended, an incision $3\frac{1}{2}$ inches long is made, in the line of the vessel, along the outer margin of the semi-membranosus, and then downwards and outwards to the centre of the space. The small sciatic nerve, if seen, should be drawn to one side; the deep fascia is then freely opened up, and the pulsation of the artery felt for at the outer margin of the semi-membranosus. The nerve is generally seen first, and this and the vein are to be drawn to either side with blunt hooks. The needle should be passed from the vein. A good deal of loose fat is usually in close contact with the vessels, and is liable to be a source of trouble wherever the artery is ligatured, especially in the dead subject.

B. At the Lower Part of the Popliteal Space (Fig. 353).—The limb being in the same position, an incision $3\frac{1}{2}$ inches long is made, in the line of the artery, from the centre of the popliteal space to the junction of the upper and middle thirds of the back of the leg. The external saphena vein and its nerve being avoided, the deep fascia is freely opened and the limb flexed. The exact interval between the heads of the gastrocnemius is next sought for. The following structures may now be met with overlying the artery, and must be drawn aside—viz., the plantaris, the sural arteries which run down on the vessel, and

FIG. 354.



The artery lies embedded in fat. Above it are some of the fibres of the adductor magnus. In the upper angle of the wound the sartorius has been drawn down.

the posterior tibial nerve, which is often given off as high as this. The popliteal vein now lies to the inner side, together with the popliteal nerve, which is superficial to it, if this has not given off its branches. These structures should be drawn to either side, and the needle passed as is convenient.

C. From the Front, at the Inner Side (Fig. 354).—This operation might be useful in cases where hæmorrhage recurs after osteotomy at the lower end of the femur (p. 1274).

The following account is taken from Sir W. MacCormac (*Ligature of Arteries*, p. 110): "Flex the knee and place the limb on the outer side. Make an incision 3 inches long immediately behind and parallel to the tendon of the adductor magnus downwards from the junction or the middle and lower thirds of the thigh. Divide the skin, superficial and deep fasciæ, avoid the long saphenous nerve, seek the tendon of the adductor magnus, draw it forwards and the hamstring tendons backwards. The artery will then be found surrounded by fatty areolar tissue. The nerve and vein do not necessarily come into view, being on the external aspect of the vessel."

CHAPTER VI.

OPERATIONS ON THE LEG.

LIGATURE OF POSTERIOR TIBIAL ARTERY.—LIGATURE OF ANTERIOR TIBIAL ARTERY.—LIGATURE OF PERONÆAL ARTERY.—AMPUTATION OF LEG.—OPERATION FOR NECROSIS.—TREATMENT OF COMPOUND FRACTURE.—EXCISION OF VARICOSE VEINS.

LIGATURE OF THE POSTERIOR TIBIAL ARTERY.

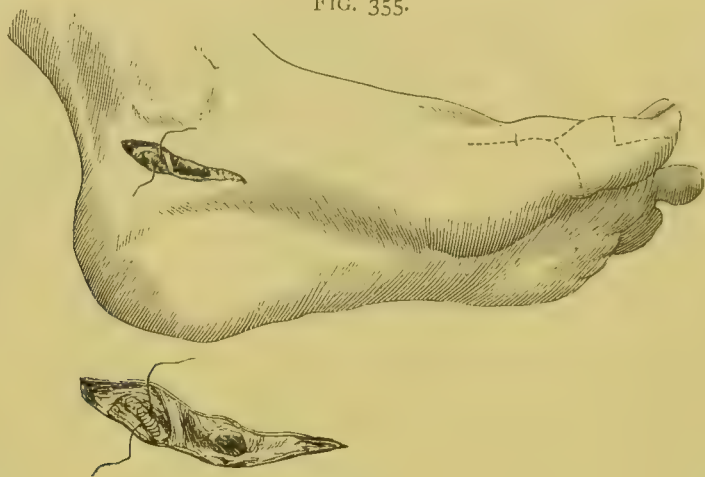
Indications.—Very rare. i. Chiefly Wounds.—Mr. Cripps,* in a very valuable paper, divides up the sources of hæmorrhage from the upper two-thirds of the posterior tibial into (1) hæmorrhage after amputation; (2) hæmorrhage from injury to the vessels in continuity. (1) Hæmorrhage after Amputation.—This is usually due to a diseased condition of the vessels, and to the fact that the vessels, lying between the bones, are now especially difficult to take up. If from their constantly breaking away it is found impossible to deal with them, the limb should at once be amputated above the knee. If the hæmorrhage occurs later on, well-adjusted pressure (p. 1166) should be carefully tried, aided or followed by ligature of the femoral or by amputation higher up. (2) Hæmorrhage from Wounds of the Tibials in Continuity.—Three chief causes may lead to this: (a) An incised wound. (b) A punctured wound. (c) Wounds other than punctured or incised. Four methods of treatment are open to the surgeon—viz., (a) Pressure and bandaging. (b) Ligature of both ends of the vessel. (c) Ligature of the femoral. (d) Amputation. (a) *Incised Wound*.—If this is seen soon after its infliction the bleeding point should be sought for and tied, the wound being enlarged, if needful. If sloughing and extravasation of blood have taken place, amputation will probably be the wiser course, though if the patient decide to run the risk, an attempt may be made to save his limb by making free incisions, providing drainage, plugging the wound (rendered as far as may be aseptic with irrigation and iodoform) with aseptic gauze, bandaging evenly and firmly, and tying the femoral in Hunter's canal. (b) *Punctured Wound*.—If this is deep, and the vessel injured uncertain, the question of treatment is a very serious one.†

* *St. Barthol. Hosp. Reports*, vol. xi. p. 94; *Dict. of Surg.*, vol. ii. p. 626.

† Where the wound has passed obliquely, Dupuytren's words should be remembered. They refer to hæmorrhage from the calf caused by a pistol-bullet. "Should a ligature be placed on the ends of the divided vessel? But what were those vessels? Was it the anterior or posterior tibial, or the peronæal or the popliteal? Was it several of them at the same time? Should they be attacked before or behind?"

Mr. Cripps shows that, in the majority of instances, pressure deserves a fair and thorough trial. If it is useless, or prejudicial to other treatment, either the femoral must be tied or the wound enlarged to secure the wounded vessel. Between these operations the features of the particular case must decide. If pressure is made use of, it should be applied methodically and with intelligent purpose (p. 1166), and so that it needs no alteration or repetition. (c) *Wounds other than Punctured or Incised—viz., Injury to the Vessel from Fracture or Gun-shot Wound.*—In many cases conditions will be present which will call for amputation—viz., the severity of the crush; the extent of the comminution; injury to the nerves or to both arteries, as evidenced by the condition of the foot; and the age or the health of the patient. In most of these cases, as an

FIG. 355.



Ligature of the posterior tibial artery at the inner ankle. The incisions in amputation of the great toe at the metatarso-phalangeal and the inter-phalangeal joints are also shown.

attempt to find the vessel involves great difficulty and danger, and the probabilities of success diminish as the interval between the infliction and treatment of the injury increases, ligature of the femoral would be less hazardous than any interference with the wound. But amputation will frequently be needed. The above remarks apply to compound fractures; an instance of successful ligature of a lacerated femoral co-existing with a simple fracture of the leg is given at p. 1162. ii. Small traumatic aneurisms. iii. The posterior tibial may be tied low down, together with the dorsalis pedis, for certain wounds of the sole or for some vascular growths of the foot.

LINE AND GUIDE.—A line drawn from a point at the lower part of the centre of the popliteal space* to one midway between the tendo-Achillis and the internal malleolus.

RELATIONS.—These differ according as the vessel is tied—(A) in the middle of the leg, (B) in the lower third of the leg, (C) at the inner ankle.

A. RELATIONS IN THE MIDDLE OF THE LEG:

SUPERFICIAL.

Skin; fasciæ; branches of saphenæ veins and nerves.

* This point, representing the lower border of the popliteus, would be about $2\frac{1}{2}$ inches below the knee-joint.

Gastrocnemius; soleus; plantaris.

Special fascia; transverse branches of venæ comites;
tendinous origin—arch—of soleus (above).

OUTSIDE.

Vena comes.

Posterior tibial nerve
which has crossed
above from the
inner side.

Posterior tibial.

INSIDE.

Vena comes.

Posterior tibial nerve
(above).

BENEATH.

Flexor longus digitorum.

Tibialis posticus.

B. RELATIONS IN LOWER THIRD OF LEG:

SUPERFICIAL.

Skin; fasciæ; superficial veins and nerves.

OUTSIDE.

Vena comes.

Posterior tibial nerve.

Tendo-Achillis.

Posterior tibial.

INSIDE.

Vena comes.

BENEATH.

Flexor longus digitorum.

Tibia.

C. RELATIONS AT INNER ANKLE:

SUPERFICIAL.

Skin; fasciæ; branches of internal saphena vein
and nerve.

Internal annular ligament.

OUTSIDE.

Vena comes.

Flexor longus pollicis.

Posterior tibial nerve.

Posterior tibial.

INSIDE.

Vena comes.

Flexor longus digi-
torum; tibialis
posticus.

BENEATH.

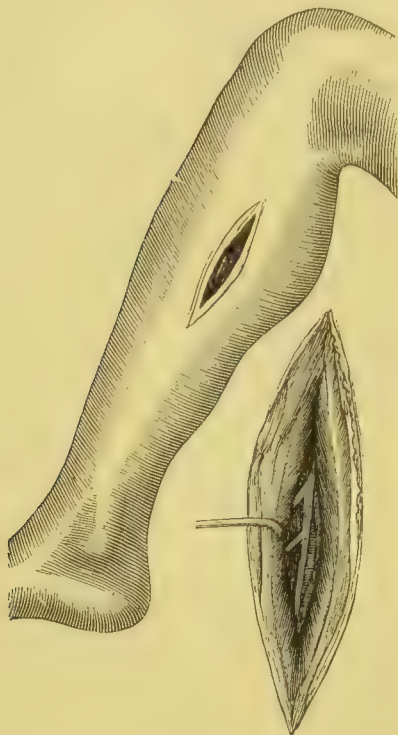
Internal lateral ligament.

Operation in Middle of Leg (Figs. 356, 357).

The parts having been cleansed, the knee flexed, and the limb supported on its outer side, the surgeon, standing or sitting on the inner side, makes an incision $3\frac{1}{2}$ inches long, parallel with the centre of the inner border of the tibia; and $\frac{1}{2}$ or $\frac{3}{4}$ inch behind it, according to the size of the limb. This incision divides skin and fasciæ. If the internal saphenous vein is met with, it must be drawn aside with a strabismus hook; any of its branches may be divided between two chromic-gut ligatures. The deep fascia

is then freely slit up, and the inner edge of the gastrocnemius defined and drawn backwards. This will expose the soleus, the tibial attachment of which is to be cut through, any sural artery being at once secured. The incision through the soleus (Fig. 357) should

FIG. 356.



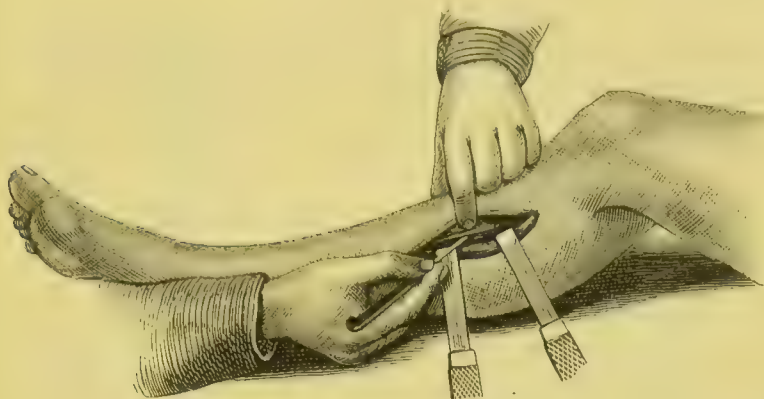
The position of the incision is shown on the figure to the left. That to the right shows the parts on a larger scale. The outer border of the gastrocnemius is seen to the right beneath the cut fat. One of the edges of the cut soleus is shown retracted. One of the venæ comites appears internal to the artery, the nerve lying to its outer side.

be 3 inches long and quite $\frac{1}{2}$ inch from the tibia; as the fibres are divided, the central membranous tendon will come into view, and must not be confused with the special deep fascia or intermuscular septum over the deep flexors. Usually, before this comes into view, some additional fibres have to be divided. When this is done, the above special fascia must be identified, stretching between the bones. The wound must be carefully dried, and well opened out with retractors, and exposed with a good light at this stage. The deep fascia being opened carefully, the nerve usually comes into view first, the artery lying a little deeper and more internal. The venæ comites should be separated as far as possible, but rather than puncture them and cause hæmorrhage at this stage, or waste time, the surgeon should tie them in. The needle should be passed from the nerve. To facilitate this, the knee should be well flexed, and the foot also flexed downwards so as to relax the muscles thoroughly. The ligature will lie below the peronæal artery.

Operation in Lower Third of Leg.—The limb and the operator being in the same position as at p. 1217, an incision, $2\frac{1}{2}$ inches long, is made through skin and fasciæ, parallel with the inner border of the tibia, and midway between it and the tendo-Achillis; after the deep fascia has been opened, another layer, tying down the deep flexor tendons, will require division. The artery here lies between the flexor longus digitorum and pollicis, surrounded by venæ comites. The needle should be passed from the nerve, which lies external. If the incision is made too high, some of the lowest fibres of the soleus will require detaching from the tibia; if too low, the internal annular ligament would be opened. The sheaths of the flexors (their synovial investment commences about $1\frac{1}{2}$ inch above the internal malleolus) should not be interfered with.

Operations at the Inner Ankle (Fig. 355).—The limb and operator being placed as before, a curved incision, 2 inches long, is made, $\frac{3}{4}$ inch behind the internal malleolus. Skin and fasciæ being divided, any branches of the internal saphena vein tied, the

FIG. 357.



Ligature of the posterior tibial at the middle of the calf. The inner head of the gastrocnemius is drawn backwards by retractors. The left index raises the anterior lip of the wound while the soleus is divided, perpendicularly to its surface. (Farabeuf.)

internal annular ligament is divided and the artery found closely surrounded with its veins. The nerve lies externally, and the needle should be passed from it. The artery is so superficial here that the veins can be easily separated. The nerve has occasionally bifurcated higher up.

LIGATURE OF THE ANTERIOR TIBIAL.

Indications.—These are very few, and resemble so closely those already given for the posterior tibial—viz., wounds and traumatic aneurism—that there is no need to go into them again here.

In the course of 1887, I had occasion to tie the anterior tibial in its lower third for profuse hæmorrhage from a compound fracture not arrested by pressure. There was a compound comminuted fracture of the right leg, in the lower third, from a fall of 4 cwt. upon the limb. The upper end of the artery was found with some difficulty, owing to the pulped-up condition of the soft parts. Having failed to find the lower end, I was about to expose the dorsalis pedis, and, trusting to antiseptic precautions, trace this up to the anterior tibial, when, an urgent strangulated hernia being admitted, I plugged the wound, all the undermined parts being previously laid freely open. No recurrence of bleeding took place, and the man (aged forty-four) made an excellent recovery, aided by his temperate life and patient ways, the freedom with which the wound was laid open (this preventing all retention of discharges), the use of dry gauze dressings only changed at rare intervals, and, not least, the fact that iodoform was thoroughly dusted in.

Dr. Shepherd of Montreal (*Annals of Surgery*, No. 1, p. 7) gives another, but more difficult, case in which the compound fracture was about the junction of the middle with the upper third of the leg. The bleeding was first arrested by pressure, on the fourth day a traumatic aneurism appeared. The artery was

exposed with difficulty,* and found partly divided, two ligatures were applied, and the patient made a good recovery.

LINE AND GUIDE.—From a point midway between the head of the fibula and the outer tuberosity of the tibia to the centre of the front of the ankle-joint. The outer edge of the tibialis anticus.

RELATIONS :

SUPERFICIAL.

Skin ; fasciæ : cutaneous branches of saphenous veins and nerves, and (below) musculo-cutaneous nerve.

Tibialis anticus and extensor longus digitorum (above), overlapping.

Tibialis anticus and extensor longus pollicis (below), overlapping.

OUTSIDE.

Anterior tibial artery.

INSIDE.

Extensor longus digitorum (above).

Tibialis anticus.

Extensor longus pollicis (below).

Vein.

Anterior tibial nerve.

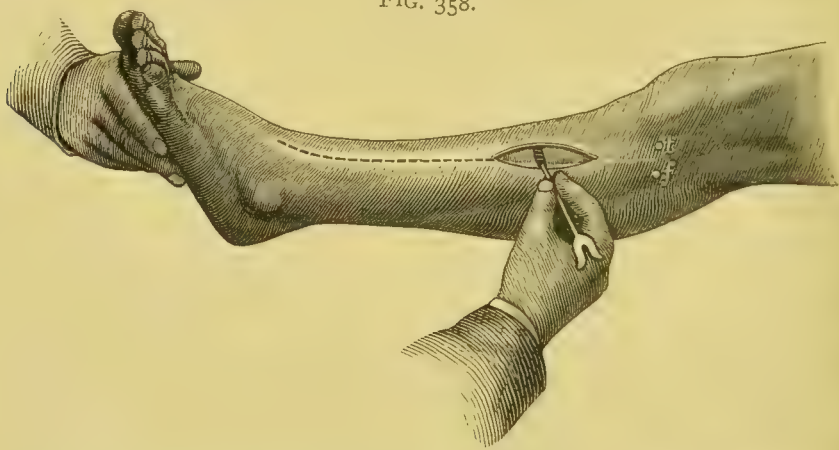
Vein.

BENEATH.

Interosseous membrane.

Operation at the Junction of the Upper and Middle Third of Leg (Figs. 358, 359).—The knee being fixed and the limb supported

FIG. 358.



Ligature of the anterior tibial artery at the junction of the middle and upper thirds ; division of the deep fascia on a director (p. 1222). (Farabeuf.)

* Dr. Shepherd points out that, the injury to the vessel being just in front of the place where it pierces the interosseous membrane, if the artery had been completely torn through, it would have retracted through the opening, and ligature would have been impossible. Mr. F. Page (*Lancet*, 1887, vol. i. p. 522) gives a case of a traumatic aneurism of ten weeks' duration, after a stab, at the junction of the middle and lower third of the leg. The swelling had been poulticed and opened, with the result of hæmorrhage. Mr. Page, on clearing out the clots and opening up the swelling, was unable to find the anterior tibial artery. Hæmorrhage recurring, the leg was amputated. The patient recovered.

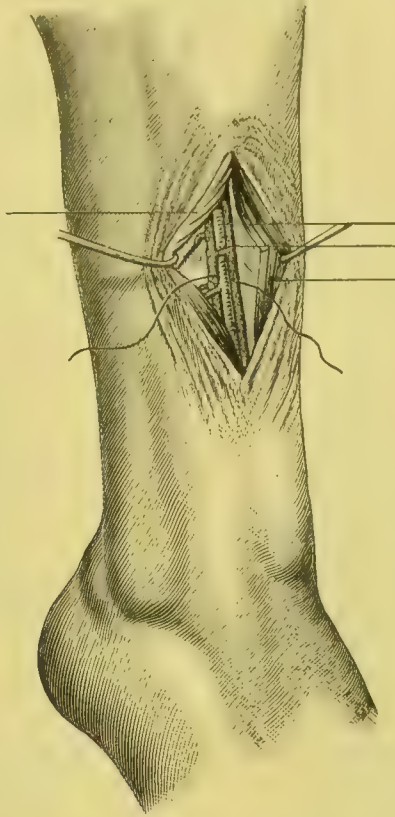
upon its inner side, the surgeon having defined if possible the outer edge of the tibialis anticus,* sits or stands on the outer side of the patient, and makes an incision about four inches long in the line of

FIG. 359.



The anterior tibial is seen with one of its veins lying between the displaced tibialis anticus and extensor longus digitorum. The muscular branch is shown, but rather too large.

FIG. 360.



Ligature of the anterior tibial artery in the middle of the leg. The tibialis anticus has been drawn to one side, and the extensor to the other. The nerve would be found on the outer side of the artery.

the artery, beginning about two inches below the head of the tibia. This incision should lie (if the edge of the muscle has not been marked out) $\frac{3}{4}$ to one inch—according to the size of the leg—from the crest of the tibia, and should expose the deep fascia carefully so that the white line which marks the desired intermuscular septum may be looked for. This line is often whitish-yellow, and varies much in distinctness. If there is any difficulty in finding it, any bleeding points must be secured, and the deep fascia slit up over the line of the artery, and the finger-tip inserted to feel for

* The patient may put this into action just before the anæsthetic is taken.

the sulcus between the muscles. A third aid is almost constant, and that is a small muscular artery* which comes up between the tibialis and the extensor longus digitorum. The sulcus being found between the muscles (without tearing them), they are separated with the handle of a scalpel or a steel director, and retractors inserted, the outer one being hooked over the fibula. If the limb is a very muscular one, the deep fascia should be nicked transversely at the upper and lower extremities of the wound, and the parts more relaxed by bending the knee more and pressing the foot upwards. The finger now directed towards the interosseous space feels for the artery deep down in the bottom of the wound. The nerve should be drawn to the outer side. If much trouble is met with in separating the venæ comites they may be included.

In a case which still presents difficulties the following directions of M. Farabeuf may be useful (*Man. Oper.*, p. 89). The two lips of the wound having been separated, the deep fascia is opened close to the inner lip and the grooved director introduced† beneath it, and pushed across gently until its tip is arrested by the first intermuscular interval and septum, that between the tibialis anticus and the extensor digitorum. If the operator pushes it too far it will be arrested by the better marked septum between the peronæi and extensors. In cutting upon it the operator will have crossed the desired interval.

Drainage having been provided, and all hæmorrhage stopped, the wound is lightly dusted with iodoform, the muscles united with one or two chromic-gut sutures, and the wound closed, and the limb kept raised and flexed.

Operation at the Junction of the Lower and Middle Third of Leg (Fig. 360).—An incision about $2\frac{1}{2}$ inches long is made in the line of the artery; in the upper part, this incision will be about 1 inch from the tibia. The white line and the interval between the tibialis anticus and the extensor proprius pollicis are both looked and felt for. The deep fascia being divided and the muscles relaxed and retracted, the artery is found surrounded by its venæ comites. The needle must be passed from without inwards.

LIGATURE OF THE PERONÆAL ARTERY.

Indications.—As these are extremely few, and as in the case of a wound of the vessel (which is very rarely met with) the best course would be to enlarge the wound, any formal operation for its ligature need only be very briefly described.

RELATIONS.—The peronæal artery comes off from the posterior tibial about one inch below the popliteus, descends at first parallel with this artery but

* This is pointed out by Mr. C. Heath (*Oper. Surg.*, p. 47). I have found the same thing most helpful in the ligature of the ulnar in the middle third (p. 54).

† Though in Fig. 374 M. Farabeuf figures the director introduced from without, he directs that it be passed as described above, and figures it so in another illustration.

separated from it by the posterior tibial nerve ; it then passes outwards towards the fibula and runs down between this bone and the flexor longus pollicis. In the upper part of its course it lies upon the tibialis posticus, and is covered by the soleus.

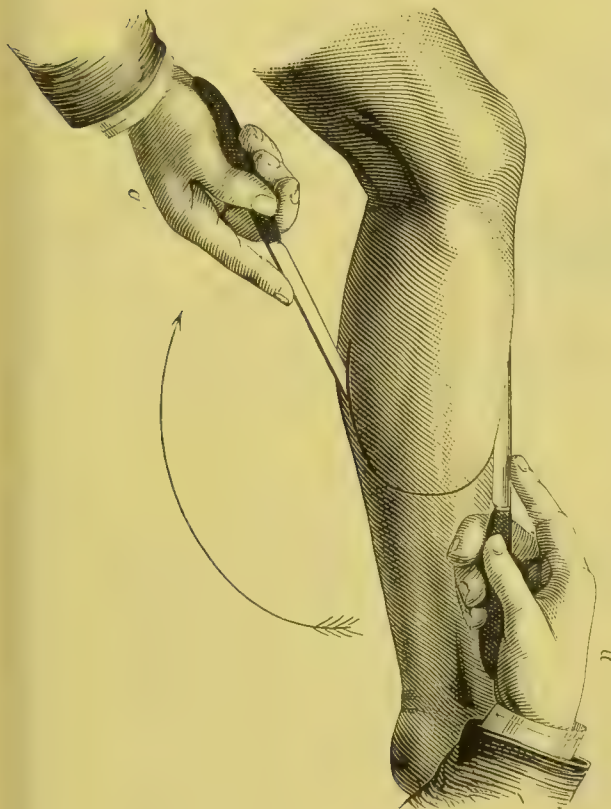
Operation.—To tie the artery when no wound is present to guide the surgeon, an incision, 3 inches long, should be made along the posterior border of the fibula with its centre at the junction of the upper and middle thirds of the leg. The gastrocnemius being drawn aside, and the soleus separated from its attachment to the fibula, the special deep fascia is slit up and the artery sought for close to the fibula.

AMPUTATION OF THE LEG.

Different Methods (Figs. 361–367).

1. **Lateral Flaps** (Figs. 361–364). 2. **Teale's Rectangular Flaps** (Figs. 365–367). 3. **Antero-posterior Flaps of Skin.**

FIG. 361.



Amputation of the leg by lateral flaps.
(Farabeuf.)

FIG. 362.



Amputation of the leg by lateral flaps. The muscles are being severed with circular sweeps of the knife.

4. **Antero-posterior Flaps, Anterior of Skin, Posterior by Transfixion of Muscle.** 5. **Circular.**

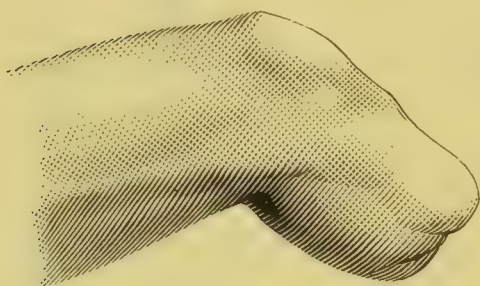
I shall only describe the first two, as they will be found adapted

to all emergencies, and to be devoid of the disadvantages of the others.

1. **Lateral Skin Flaps, with Circular Division of the Muscles, &c.**—This is, I believe, a method not well known beyond Guy's and those who have been taught there. It will not only be found most convenient at the time, but it also gives very satisfactory results afterwards. The blood-supply is well and equally distributed to the lateral flaps, one can be conveniently cut longer than the other, and they are more easily shaped and dissected up than antero-posterior skin-flaps, while no mass of muscle is left to drag away from and expose the bones, as in the antero-posterior flaps, with the anterior of skin and the posterior by transfixion.

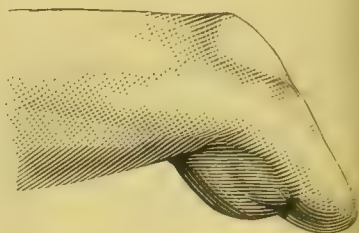
Operation (Figs. 361–364).—The femoral artery having been commanded, the leg brought over the table, and the damaged or

FIG. 363.



Amputation of the leg at the seat of election, by lateral flaps, a good stump resulting. (Farabeuf.)

FIG. 364.



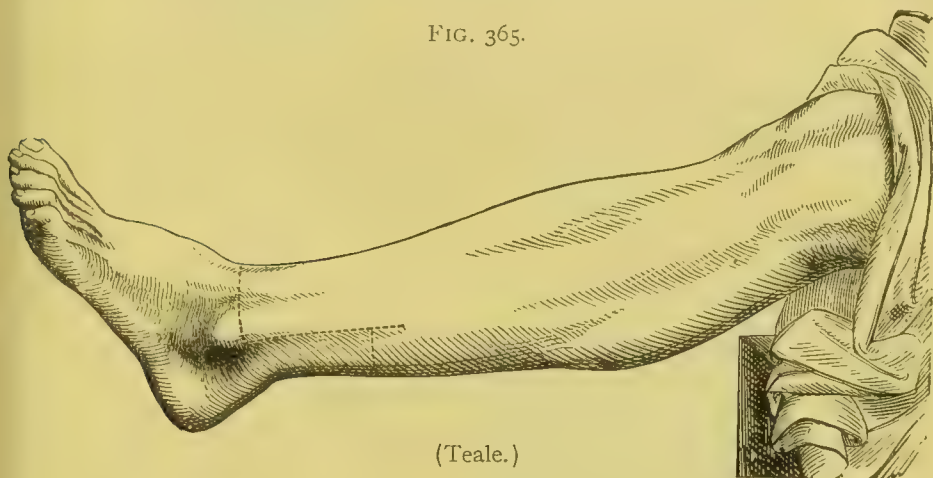
Amputation of the leg by lateral flaps, at the seat of election. The posterior muscles, cut too high, have retracted greatly, and an ugly conical stump is the result. (Farabeuf.)

diseased parts wrapped in carbolised lint so as to give the assistant a firm hold and also to prevent his soiling the flaps later on; the opposite ankle is tied to the table. The surgeon standing to the right of the limb places his left index on the crest about an inch below the tubercle, and his thumb at a corresponding point behind in the centre of the limb. Looking over he inserts his knife close to the thumb and cuts on the side of the limb farthest from him a lateral flap broadly oval in shape and 3 inches long, ending at the index finger, from which point, without removing the knife, a similar flap is marked out ending on the back where the first began. The flaps are now dissected up of skin and fasciæ, and the muscles all cut through with a circular sweep of the knife at the intended point of bone-section, this sweep being repeated two or three times till the soft parts are, all, cleanly severed. The posterior muscles should be cut a little longer than those in front, owing to their greater retraction (Figs. 363, 364). The interosseous membrane is next divided, so that it shall not be frayed by the saw, and with one final, firmly drawn, circular sweep the periosteum is grooved

for the saw.* This is then applied with the following *precautions*. The position of the fibula behind the tibia and its much smaller size must be remembered, lest it be splintered. This may be avoided by rolling the leg well over on to the inner or outer side as the case may be, and placing the saw well down on the outer side so as to start the section of the bones simultaneously, and thus ensure complete division of the fibula before the tibia. This object may also be effected, if the leg is held in the ordinary position, by applying the saw to the tibia, and remembering, when this bone has been sawn half-through, to depress the handle, and thus complete the section of the bones simultaneously. In either case the saw should be used lightly and quickly, with the whole length of the blade, and without jamming. As the sharp projecting angle of the crest tends to come through the anterior angle of the flaps, this may be sawn off obliquely after the bones are sawn.

Teale's Amputation by Rectangular Flaps (Figs. 365-367).
—This method is rarely employed. In hospital practice, where

FIG. 365.



(Teale.)

amputation of the leg is usually called for, amputation at “the seat of election,” so that the patient can bear his weight on parts used to pressure, is always preferable, and lateral flaps give here the best results, at the least expense of tissue, and in the shortest time. In the better ranks of life, where the patient can afford and use comfortably a well-moulded leather socket,† a longer stump may be made, as the pressure will now not be taken on the face of the stump, but distributed over the socket.

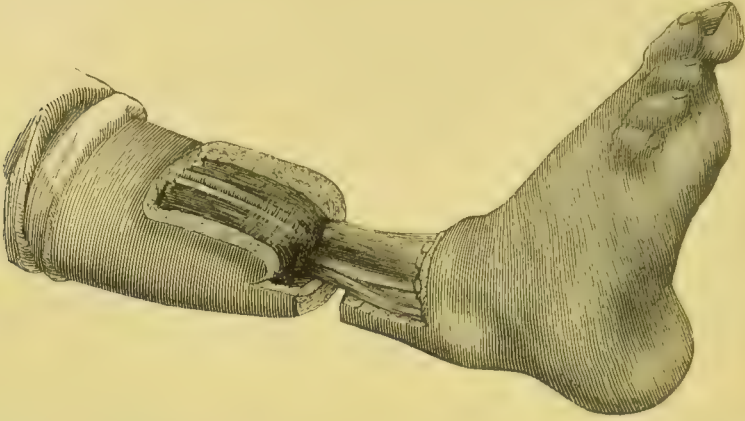
* Nowadays, with antiseptic precautions, the old need of periosteal flaps—viz., to keep pus, &c., out of the diploë and medullary canal—is no longer present. Furthermore, these flaps are very difficult to raise, unless inflamed, especially in the thin periosteum of adults.

† Hospital patients occasionally ask for and get together the money, on the first occasion, for one of these expensive legs. The well-moulded socket on which the bearing of the weight comfortably depends is quite unfitted for the hard wear and tear, perspiration, &c., to which it will be submitted.

Advantages.—1. The covering for the bones is ample, and the flaps come together without tension.* 2. The way in which the flaps are united favours drainage during healing, and provides a scar well out of the way of pressure. 3. The stump bears pressure well.

Disadvantages.—1. It is an expensive method, involving a high section of the bones. 2. The long anterior flap may slough. 3. If performed with the accuracy

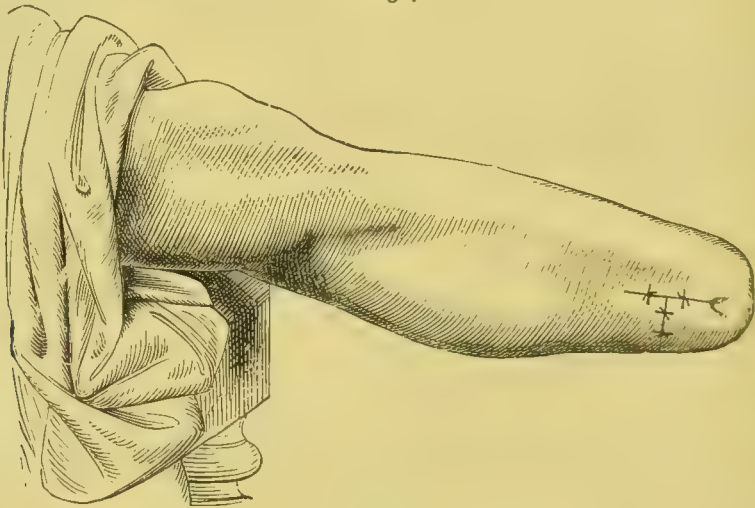
FIG. 366.



of its introducer, it involves more time than that by lateral flaps (*vide supra*), and is, thus, not suited to cases of shock.

Operation.—The preparatory steps, and the position of the operator and patient, are as at p. 1224. The surgeon having measured the circumference of

FIG. 367.



(Teale.)

the limb at the spot where he intends to saw the bones, and placing here his left index and thumb on the tibia and fibula, traces out a long rectangular, anterior flap which is to be, both in its length and breadth, equal to half the above circumference.† In tracing this flap the incision starts from the index finger, runs down along the bone farthest from the surgeon for $4\frac{1}{2}$ inches (if the

* Save when infiltrated, the difficulty of getting the anterior flap into position is then often considerable.

† In the lower third, where the leg tapers quickly, care must be taken to keep this flap of the same width below as it is above.

circumference at the site of bone-section is 9 inches), then crosses the limb, cutting all the structures down to the bones—this end of the flap being also $4\frac{1}{2}$ inches wide—and then travels up along the opposite bone to the surgeon's thumb. The anterior flap is then dissected up partly with the knife—*e.g.*, on the inner side, where the scanty coverings must be raised as thick as possible and without scoring, partly with the knife and partly with the finger on the outer aspect, where the extensors, anterior tibial vessels and nerve must be stripped up, uninjured, from the interosseous membrane (Fig. 366). The posterior flap, which has been previously marked out fully $\frac{1}{2}$ in length of the anterior, is now made by the surgeon looking over the limb and passing his knife beneath it, and cutting everything down to the bones. It is next raised as high as the point where the bones are to be sawn. The interosseous membrane and the bones are then attended to with the precautions given at p. 1224.

The vessels being secured and drainage provided, the anterior flap is folded over the bones (care being taken not to double it too sharply), its cut end stitched to the cut end of the posterior flap, and the portion folded below the bones stitched to that folded above them (Fig. 367).

SEQUESTROTOMY.

As the removal of necrosed bone is most frequently required in the leg, the above operation will be described here.

Indications.—The question will often arise as to whether the case is ripe for operation. The chief points bearing upon this, and the looseness of the sequestrum, are—(1) The time that has elapsed since the beginning of the illness; thus, two to three months will probably be required in the case of the tibia, but more likely six in that of the femur; (2) the age and general health* of the patient. The younger the patient, and the more vigorous his vitality, the more rapidly will the sequestrum become detached; (3) the size of the sequestrum. The larger and more tubular the sequestrum, the slower will be the process; (4) the feel of the sequestrum. When steel probes announce this to be dry, hard, and ringing, exploration is justified, especially if the sequestrum can be felt to be loose or depressed by the probe; (5) the size and amount of the new shell of bone. The more distinct this is, the more probable is it that the process of separation is complete.

Operation.†—This should be always conducted with strict anti-septic precaution throughout—*e.g.*, with careful irrigation with a solution of mercury perchloride (1 in 3000), and for these reasons—(a) to prevent any risk of setting up septic osteo-myelitis; (b) to diminish the amount of suppuration, and so the risk of necrosis after the interference with the periosteum which is entailed by the operation.

The limb having been rendered evascular by vertical elevation while the patient is taking the anæsthetic, and the application of Esmarch's bandages, is firmly supported on sand bags, steel probes are placed in the cloacæ which mark the limit of the disease, and

* Freedom from syphilis and phthisis will be noted.

† It is supposed here that the sequestrum is one of considerable size.

with a strong-backed scalpel the surgeon makes an incision between them on the inner surface of the tibia down to the bone. If only one sinus is present, this will probably be taken as the centre of the incision. The soft parts being reflected, with every care of the periosteum, partly with the finger, partly with a blunt dissector, the new sheath of bone, spongy and vascular, is thoroughly exposed with a chisel and mallet. This is then cut into and sufficiently removed so as to expose its cavity completely from end to end.* The sequestrum is now removed with sequestrum-forceps, or prised out with an elevator. If too large, it must be divided with cutting-forceps. The bed of ill-formed granulation-tissue in which the sequestrum lay is then carefully examined for any small bit which may be concealed, and this tissue is all scraped away with a sharp spoon. When the surgeon is satisfied that all the mischief has been removed, he plugs the resulting cavity carefully with gauze wrung out of carbolic lotion (1 in 20), dusted with iodoform, bandages these dressings firmly on while the limb is elevated, and not till then removes the Esmarch's bandage. If the bandage is removed before the dressings are applied, such free venous oozing takes place that the plugs are at once loosened and rendered inefficient, and the wound has to be redressed shortly. The limb is kept raised on a back splint and an injection of morphia given, if needed.

Two questions with regard to sequestrotomy require to be alluded to—viz., that of performing early sub-periosteal resection—*i.e.*, as soon as the bone is dead, and before any shell of new bone has formed around it, and that of amputation.

Early Sub-periosteal Resection.—Mr. Holmes (*Surgical Treatment of Children's Diseases*, p. 385) has discussed this question, and given the following *advantages and disadvantages*: "The *advantages* of sub-periosteal resection of the shaft of the bone over the expectant treatment are: (1) That it takes away what is a source of very acute and dangerous constitutional irritation, and (2) that it avoids the embarrassment of future operations, and the tediousness of the convalescence which follows on the invagination of a large sequestrum." The chief *drawback* is the risk of more or less shortening.

The certainty of shortening which takes place here, although the fibula is present to act as a stay, and to prevent any approximation of the ankle to the knee, is a much more serious drawback, and when coupled with the fact that the patients who would be submitted to early sub-periosteal resection are often only just recovered from a very prostrating illness seems to me to be strongly against it in most cases.

Question of Amputation.—The following are some of the conditions which will call for this operation: (1) When the

* Mr. Howse (*Brit. Med. Journ.*, 1874, vol. i. p. 475) lays great stress on the need of this. The new bone should be removed as far as the probe can be passed upwards or downwards inside it, so as to make the whole easily granulate up from the bottom. Otherwise, the part that is not laid open will very likely persist with a sinus. Furthermore, laying the whole cavity open not only ensures its granulating up from the bottom, but also allows of the removal of all ill-formed granulation material.

patient's vitality is so low as to be unable to repair the wound of an early sub-periosteal resection, or to stand the tax upon it of the expectant treatment; (2) When the epiphyses are perforated, and the knee or ankle (especially if both are affected) are involved; (3) If a condition of chronic septicæmia is present; (4) If the general health, from the presence of phthisis, lardaceous disease, or syphilis, is much impaired.

TREATMENT OF COMPOUND FRACTURES.*

The following special points for consideration arise here—viz., (1) The reduction of protruding fragments and the treatment of splinters; (2) The best mode of dressing the wound; (3) Complications; (4) The question of amputation.

(1) *Protrusion of Fragments.*—It is usually the upper one which protrudes. The difficulty of reduction is in proportion to the size of the wound, the length of the protruding bone, and the amount of spasm. If reduction cannot be effected by moderate extension and dextrous manœuvring, the wound must be enlarged, and if this is not sufficient, part of the bone must be removed with a narrow-bladed saw (Adams' osteotomy saw will be found very useful), care being taken to separate the periosteum first, and to protect the soft parts with a blunt dissector passed under the bone and by retractors. If the bone is splintered, some judgment is required as to what pieces to remove. Those which are still adherent by their periosteum should be left. Those completely torn away must be removed, whether they carry their periosteum or not. As to a third set partly adherent, partly not, these, as a rule, partially die in proportion to the injury to their periosteum, and keep up for a long time irritation, and delayed union with, perhaps, suppuration, erysipelas, &c. They must, therefore, as far as practicable, be removed, counter-openings being made for the purpose, when they cannot be reached through the wound.

(2) In *dressing the wound* the one great object is to convert the fracture as soon as possible into a simple one. In less severe cases, sealing a small, clean cut wound at once with dry gauze, and collodion, and iodoform, or tinct. benz. co., will be sufficient. But in those cases, common enough in large hospital practice, where the wound is extensive and lacerated, and accompanied by great contusion of the soft parts, with abundant blood extravasation, with much comminution of fragments and injury to the periosteum, or where the fracture is complicated with a dislocation, the antiseptic method will be found to give the best results in the largest number of cases.

While an anæsthetic is given, the limb is cleansed with lint, and

* From the frequency with which these occur in the leg this subject will be treated here. The account is taken largely from the article "Fractures," *Syst. of Surg.*, vol. i. p. 421, which I rewrote in 1882.

1 in 2000 solution of hydr. perch. An Esmarch's bandage being applied, and the wound enlarged, the bone which requires it (*cide supra*) is removed, any vessels secured, and a 1 in 30 solution of carbolic acid is injected into all the recesses of the wound by means of a syringe with a gum-elastic catheter attached by tubing. Prof. Lister has shown that this must not be done too vigorously, as extensive injection of the cellular interspaces may set up serious irritation and sloughing. For this reason he advises that the outlet of the wound should not be held closed around the catheter, but left freely open during the syringing. Irrigation with mercury perchloride solution should always be employed, any very undermined parts slit up, and free counter-openings made for drainage. All hæmorrhage being arrested, and any torn nerves pared and sutured, the recesses of the wound are dried with sponges on holders; powdered iodoform* and Jeyes' powder are then dusted in, dressings of carbolised iodoform gauze applied, and the limb put up either in a back and two side splints, or, according to Mr. Croft's directions, in plaster-of-Paris. Of the two I prefer the former, in severe cases, for the first week; infrequent dressings, wherever practicable, are most essential.

(3) *Complications*.—My space will only allow me to enumerate these. They are local and general. The former include pruritus, vesicles, ecchymosis, suppuration, oedema, phlebitis, gangrene, osteitis, caries, necrosis, muscular spasms, dislocations, and implication of a neighbouring joint. The general complications are such as are common to all injuries—viz., traumatic fever, delirium, erysipelas, septicæmia, pyæmia, hectic, tetanus, jaundice, and retention of urine; in older patients a tendency to hypostatic

* This most valuable drug is not sufficiently used in these cases. I may briefly mention three cases in which limbs were, I think, saved by it. One was a very severe compound fracture of the femur in a man, aged forty-six, who fell twenty-two feet on to the banks of the Thames, striking a stone buttress as he went down. I saw him about an hour after the accident. The fragments were much displaced and overlapping, the lower one being also split vertically, but not so far as the knee-joint. The ends of both were bare, and the vastus externus and hamstrings were lacerated, the injury having been made greater by the patient having been lifted off the mud on to which he fell into a boat, and then into a cab. Ether having been given, the external wound, through which the vastus externus protruded, was freely enlarged, and its recesses well washed out with 1 in 30 carbolic-acid solution, as advised above. About 5j of iodoform was then carried down right between the fragments by means of the finger and a narrow spatula, and two large drainage-tubes inserted. An aseptic result was secured from the first and maintained, throughout, by the dresser (Mr. J. H. Lister), the man making an excellent recovery. The second case was that of a compound comminuted fracture of the leg, with wound of the anterior tibial artery (mentioned at p. 1219). The third occurred in a boy with compound separation of the lower epiphysis of the tibia, in which two inches of the protruding diaphysis were removed. The case did so well after the introduction of iodoform and the other precautions already given, that the first dressings were not removed till the eighth day, and the lad recovered with an excellent limb.

congestion and broncho-pneumonia, and finally, in a few cases, pulmonary fat-embolism.

(4) *Question of Amputation.*—The following are amongst the conditions requiring primary amputation: (1) When a limb is torn off by a cannon-ball, a portion of shell, or by machinery. (2) When the division of the soft parts is nearly complete, except in the case of a clean cut across the phalanges, metacarpus, or metatarsus; even the forearm may occasionally be saved under similar circumstances. (3) When there is much actual loss of soft parts, as when one side of a limb is torn away, or the skin is extensively peeled off. (4) When, with or without great comminution of the bones, there is much bruising and laceration of the soft parts, with protrusion of muscular bellies, and extensive tearing up of deep planes of areolar tissue. (5) In some cases when the principal artery and nerves of the limb are both divided, thus, in the case of the lower limb, primary amputation will usually be required. (6) In certain cases of severe hæmorrhage, primary or secondary. On this subject I must refer my readers to the remarks already made at p. 1215. (7) Some cases of compound fracture of large joints—viz., when one bone is shattered or more than one is broken; when there is much laceration of the ligaments; when, in addition to comminution of the bones, there is much contusion of the soft parts, especially if complicated with division of an artery; when the foreign body which has caused the fracture remains in the joint, or, projecting into it from its bed in the bone, cannot easily be removed, or when there is much damage to the articular surfaces. It will be understood that all these forms of injury are most fatal when affecting the knee or hip; in dealing with other joints much greater latitude may be allowed.

Finally, before deciding on amputation, the surgeon must take into consideration, in addition to the above points which concern the fracture itself, any general information to be gained about the patient himself. Thus, the age, constitution, habits, any sign of visceral disease, and the appearance of the patient, are all points of material importance in coming to a decision between amputation and an attempt to save the limb. Thus, to make my meaning clearer, there are no more anxious cases than severe compound fractures in dwellers in large towns, who are past middle life, flabbily fat, with dilated venules about the cheeks and nose, whose conjunctivæ are slightly jaundiced, the urine of low specific gravity and perhaps albuminous.* The surgeon must here bear in mind that saving the patient's life is, after all, of more importance than the preservation of his limb.

In performing amputation in these cases of compound fracture it is always to be remembered that the injury is not so localized as

* Note will also be taken of the occupation, as in brewers'-draymen and commercial travellers.

would appear from the surface; thus, in compound fracture of the leg there is often extensive loosening of the skin from the deep fascia, and extravasation of blood into the deep planes of connective tissue for some distance above, the knee-joint being perhaps full of blood, and its cartilages bruised. In such cases, if amputation be performed just above the injury, sloughing and separation of the flaps will inevitably follow. On the other hand, in cases of severe compound fracture of the thigh, where amputation is required high up, it will be found better practice to amputate, in part at least, through injured tissues*.

If, in addition to the fracture, there are serious injuries to other organs, immediate amputation is useless or injurious. The only chance of recovery here is afforded by secondary amputation, after the early dangers are past.

Secondary amputation may be required for profuse suppuration with hectic, for gangrene, or uncontrollable hæmorrhage. The decision must here be made according to the needs of each case. The surgeon must, if possible, wait till the traumatic fever and constitutional disturbance are subsiding, till the temperature has begun to fall, and till all redness, erysipelas, and sloughing have ceased. On the other hand, if the operation be deferred till the powers of the patient are running down from profuse suppuration and hectic, and till confirmed asthenia has set in, the period of performing it will, very probably, have passed away.

At a still later period the operation may be desired by the patient, if, in consequence of non-union, incurable deformity, or tedious bone disease, the limb has become an encumbrance to him. Some of these conditions may, of course, be treated by resection, osteotomy, &c.

EXCISION OF VARICOSE VEINS.

This method, as old as the times of Celsus, and one which fell into disuse from the risks of pyæmia, &c., was revived with safety some years ago by Mr. Davies-Colley (*Guy's Hosp. Reports*, 1875, p. 431), when Sir Joseph Lister had shown how the old dangers might be avoided.

Indications.—Safe as this operation has been made, it is to be recommended with caution owing to the great risk of recurrence. If this operation is largely employed and the cases are carefully watched, it will be found after some years that the amount of permanent benefit ensured is, in many cases, very small.

Before the varices are removed it must be ascertained that the better supported deep veins, through which it is intended that the blood shall largely return after the superficial ones are obliterated, are healthy.† The cases best suited for

* Thus, in the case of a young railway porter, whose thigh was smashed by a railway accident at Epsom, I performed amputation at the level of the lesser trochanter, in preference to the hip-joint. The damaged flaps sloughed, as I expected, but the patient made a good recovery, after the removal of some dead bone. The precautions already given against shock (p. 1135) will, of course, be taken in these cases.

† A full tumid condition of the calves points to a varicose state of the sural veins, and is against operation.

operation are : (1) Where only one vein-trunk is involved, at one or two definite parts of its course. (2) Where both saphenous veins are involved, but again definitely and locally. The more the varices are longitudinal, the more they lie in the lines of the trunk, the more longitudinal incisions will suffice, the more satisfactory the operation and the better and more lasting the results. On the other hand, where the enlargement is bilateral and general, where numerous communicating veins between the trunks are enlarged, involving incisions more or less transverse, where the venous radicles are becoming dilated and their ramifications plexiform, the more, in short, that the disease shows signs of being a general one, the more will the result be disappointing. Finally, the soft parts near the varices should be in a healthy condition, free from dermatitis, and thus capable of being rendered aseptic, and of uniting quickly afterwards. In the two following conditions operation may occasionally be called for, though the conditions required above are not now, always, present. (3) Where many varices exist, but one or two are especially troublesome. (4) Where many varices exist, but one especially is, definitely, the cause of an ulcer troublesome to heal, and perhaps already the source of dangerous bleeding (Fig. 368).

Operation.—In order to keep the veins distended, the patient should stand about for a short time before the operation, and when he lies down on the table the legs should hang over the end. The skin will, of course, before have been carefully cleansed. A longitudinal incision having been made over the chief varices—where the trunk is merely dilated segments about 3 inches long should be removed—

the subcutaneous fat is opened, the vein exposed by light touches of the knife for the whole of the extent which it is proposed to excise, a fine catgut ligature is then tied round the lower end, the vein, held in dissecting forceps, is cut through just above the ligature, dissected out, any branch-veins clamped with Spencer Wells' forceps, until the upper extremity of the wound is reached, when another ligature is tied round the vein, and the varix removed. Any clamped points are then tied, and the wound closed by a trusted assistant, while the operator proceeds to deal with another vein. I will venture to commend the following **cautions** to my younger readers. (1) The strictest aseptic precautions will, of course, be taken throughout. (2) Care should be taken in exposing the varix; though, from its position, this may appear to be part of a main trunk, it may only overlap this, which may need no interference (Davies-Colley, *loc. supra cit.*). (3) Every bleeding-point should be carefully tied, otherwise tension will occur, undermining of the edges of the wound by bloodclot,

FIG. 368.



Case of varicose internal saphena vein, with dermatitis and ulceration below. From the ulcer severe hæmorrhage had occurred. I saw the woman three years after the operation on the varicose veins, and she remained well, but I have lost sight of her since.

suppuration and delayed healing. (4) The close proximity of the nerve-trunks must be remembered. Hasty operating may easily lead to removal of part of one of these. This is only justifiable when varices are being removed from the leg of a patient who complains bitterly of the pain caused about either malleolus by a clump of plexiform dilated varices, and where it is doubtful if the removal of the varices above will relieve this. (5) The catgut used should be fine and thoroughly prepared, otherwise it will work out vexatiously, a result rendered the more probable if the patient persists in getting about too early.

CHAPTER VII.

OPERATIONS ON THE FOOT.

LIGATURE OF THE DORSALIS PEDIS.—SYME'S AMPUTATION.—ROUX'S AMPUTATION.—PIROGOFF'S AMPUTATION.—SUB-ASTRAGALOID AMPUTATION.—EXCISION OF THE ANKLE.—ERASION OF THE ANKLE.—EXCISION OF BONES AND JOINTS OF THE TARSUS.—EXCISION OF ASTRAGALUS.—EXCISION OF OS CALCIS.—MORE COMPLETE TARSECTOMY FOR CARIES.—REMOVAL OF WEDGE OF BONE, AND OTHER OPERATIONS FOR INVETERATE TALIPES.—CHOPART'S AMPUTATION.—TRIPPIER'S AMPUTATION.—AMPUTATION AT METATARSO-PHALANGEAL JOINT.—AMPUTATION OF THE TOES.

LIGATURE OF THE DORSALIS PEDIS (Fig. 369).

Indications.—Very rare. (1) Wounds. (2) Together with the posterior tibial in the lower third, for hæmorrhage from punctured wounds of the sole resisting other treatment. (3) For some vascular growths of the foot.

LINE.—From the centre of the ankle-joint to the upper part of the first interosseous space.

GUIDE.—The above line and the adjacent tendons of the great and second toe.

RELATIONS : IN FRONT.

Skin, fasciæ; branches of saphenous veins, and of musculo-cutaneous and anterior tibial nerves.

A special deep fascia continuous with the sheaths of the adjacent tendons.

Extensor brevis (innermost tendon).

OUTSIDE.

Vein.

Anterior tibial nerve.

Extensor longus digitorum.

INSIDE.

Vein.

Extensor longus pollicis.

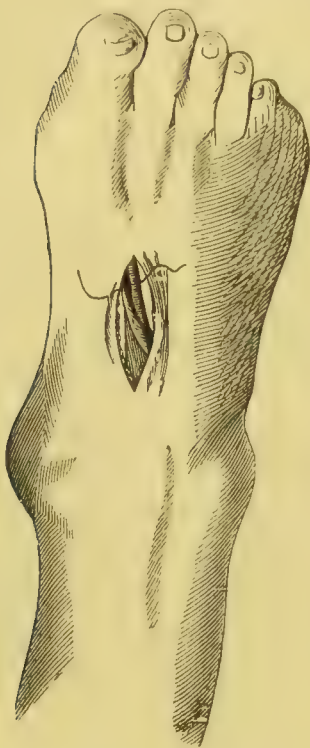
Dorsalis pedis artery.

BEHIND.

Astragalus; scaphoid; internal cuneiform.

Operation (Fig. 369).—The foot having been cleansed, an incision about $1\frac{1}{2}$ inch long is made in the line of the artery, in the lower part of its course, commencing about $1\frac{1}{2}$ inch below the ankle-joint. Skin and fasciæ being cut through, and any superficial veins tied with chromic gut or drawn aside, one of the long extensors is found (its sheath is not to be opened), and the strong fascia given off from them opened. If the extensor brevis cross the artery at this spot it must be drawn aside. The ligature should be passed from without inwards.

FIG. 369.



The dorsalis pedis (too much of the artery is shown cleaned) is seen lying between the extensor longus pollicis and digitorum, and crossed by the innermost tendon of the short extensor.

SYME'S AMPUTATION.

(Figs. 370–373.)

An amputation at the ankle-joint by a heel-flap, with removal of the malleoli.

Operation.—Hæmorrhage having been controlled, any sinuses present scraped out, the foot bandaged,* and held at right angles to the leg, the surgeon, standing a little to the right, but so as easily to face the sole, makes, with a short, strong knife, an incision (in the case of the left foot) from the tip of the external malleolus to a point $\frac{1}{2}$ inch below † the internal one, this incision not going straight across the sole as in Pirogoff's amputation, but pointing a little backwards towards the heel.‡ The horns of this incision are then joined by one passing straight across the joint,§ and severing everything at once down to the ankle-joint. The foot being now strongly bent downwards, the lateral ligaments are severed, and the joint thus fully opened. The foot being slightly twisted from

* So as to give a grip, and also to prevent the assistant's hands from being septic when he supports the stump a little later.

† The directions usually given are to go behind this point as well as below it, but by following the above course the posterior tibial is more likely to escape section before its time, and the flap will be found sufficiently symmetrical.

‡ If the foot is small, and, still more, if the parts on the dorsum are damaged, the plantar incision should run straight across. On the other hand, the more prominent the heel, the more should the flap point backwards. This will facilitate turning the flap over the heel.

§ Or with very slight convexity. If anything of a flap is made here, the operator is liable to get away from the joint and cut into the neck of the astragalus. Moreover, the parts are not well nourished, especially if sinus-riddled or undermined.

side to side, the soft parts on either side are carefully divided, especial precautions being taken on the inner side to cut the posterior tibial artery as long as possible (to ensure getting below the internal calcanean) and not to prick it afterwards.

The foot being still more depressed, the upper non-articular surface of the os calcis comes into view, and then the tendo-Achillis. This is severed, and the heel-flap next dissected off the os calcis from above downwards, especial care being taken to cut this flap as thick as possible, not to score or puncture it, but rather to peel it off the bone with the left thumb-nail kept in front of the knife, aided by touches of this.*

The foot having been removed, the soft parts are carefully cleared off the malleoli, and a slice of the tibia sufficiently thick to include these prominences removed. This slice should in any case, to avoid shortening, be the thinnest possible. Prof. Macleod† has recommended to remove only the malleoli, leaving the cartilage on the under surface of the tibia. I have followed his advice in my last eleven cases—in one, a private patient of sixty-three, where I had not the carrying out of the after-treatment, the cartilage exfoliated. The others were all younger patients—in one, in addition to the disease of the tarsus, active secondary

sypilis was present; in all, in spite of tubercular sinuses in three which required repeated scraping out (Fig. 373), no exfoliation took place. If the stump can be kept aseptic, Prof. Macleod's advice seems to me well worth a further trial, as it entails less shortening of the limb and does away with the risk of septic phlebitis, which may be brought about by opening the cancellous tissue. If, on the other hand, the lower end of the tibia is diseased, it must be removed and the sawn surface gouged or treated with a sharp spoon. If the cartilage is only slightly diseased, it may be sliced off with the knife, and here and there treated with a gouge.

FIG. 370.



The parts in a Syme's amputation before the heel-flap is adjusted (left side). The bones are shown above with the extensor tendons and the anterior tibial vessels, and, below, the tendo-Achillis. On the inner side the flexor tendons and the plantar arteries are shown cut; on the outer side, the peronæi. This figure should be contrasted with Fig. 375.

* If, in a young subject, the epiphysis comes away in the heel-flap, it may remain there if the parts are healthy. The same course may be followed with the periosteum, if it is found loose and peels easily away. Mr. Johnson Smith, when amputating both feet for frost-bite, left the periosteum on one side. On the other no attempt was made to save it. The first stump was much larger than the other, harder, and more rounded; more like that of a Pirogon's amputation.

† *Brit. Med. Journ.*, 1869, vol. ii. p. 239.

Tendons are now cut short, sinuses laid open or thoroughly scraped out, and the vessels secured. Free oozing is often present in chronic pulpy cases, or where the periosteum has been left in the heel-flap. It is best treated by firm pressure with dry dressings, and elevation of the stump. Drainage having been provided,



Roux's amputation at the ankle-joint by an internal flap. Below is shown a foot upon which the operation has been performed. (Smith and Walsham.)

the sutures are inserted; where many sinuses have been present along* the line of the incision, it is no good uniting the wound closely.

Roux's Modification of Syme's Amputation (Figs. 371, 372).—In cases where a satisfactory heel-flap cannot be obtained, an efficient substitute can be got by a large internal flap.

The incision is commenced at the apex of the outer malleolus, and carried half across the front of the ankle-joint, from whence it should run inwards in an oblique direction over the astragalo-scapoid joint, then pass, in a curved manner, downwards and backwards to the middle line of the sole of the foot, and, running along the under surface of the heel, ascend the posterior aspect of that part, and terminate at the outer malleolus, where it commenced. The ankle-joint should be opened at its upper and outer part, the calcis dissected

* Sinuses which have been scraped out will give good drainage if enlarged. If any puncture has been made in the heel-flap, it should be utilized for the same purpose. Where a diseased foot has been long on a back-splint, the skin over the tendo-Achillis may be so thinned that it is advisable to make a counter-puncture here and insert a tube.

from its connections, the malleoli and a slice from the articular surface of the tibia removed, and the operation will be complete. The shape of the flap will be gathered from the appearance of a foot operated upon (Fig. 371).

Causes of Failure after Syme's Amputation.

—(1) Sloughing of the heel-flap. This is nearly always due to faulty operating, to scoring or "button-holing" the flap, or to dividing the posterior tibial high up.* (2) Persistence of sinuses and tubercular disease. If, in spite of repeated scraping out (Fig. 373) with the aid of

anæsthetics, this condition recurs inveterately and spreads along the sheaths, the limb must be amputated higher up. This will, however, be rarely called for with perseverance on the part of the patient and surgeon, and a determination on the part of the latter to treat this condition as a kind of malignant disease. If one or two sinuses remain, and look likely to persist, scraping out should be resorted to at once. (3) Recurrence of caries in the tibia. (4) Death of the tendo-Achillis.

This rare sequela occurred to me in 1890. The patient was an aged inmate of the Camberwell Infirmary. A bluish undermined patch being laid open on the back of the ankle some weeks after the amputation, the tendon was found to have died up to its junction with the calf muscles. After its removal the parts healed soundly.

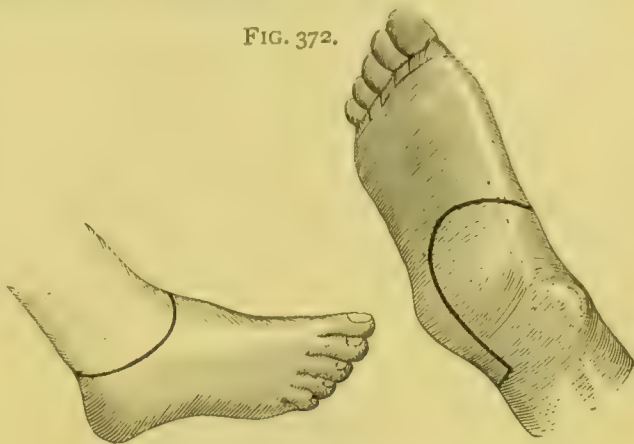
PIROGOFF'S AMPUTATION.

(Figs. 374-378.)

An amputation at the ankle-joint, in which the posterior part of the os calcis is retained and united to the sawn surface of the tibia.

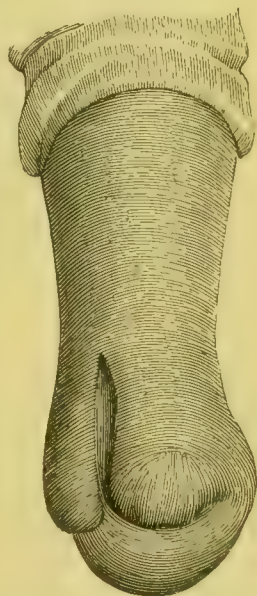
Question of the Value of this Operation especially as compared with Syme's Amputation.—*Disadvantages:* These have been

FIG. 372.



Roux's amputation. The incisions shown from the outer and the inner side. (Stimson).

FIG. 373.



A Syme's stump soundly healed after scraping out of sinuses had been resorted to. The patient was sent to me by Dr. Fraser, of Romford, and had active secondary syphilis as well as extensive caries of the tarsus.

* If possible, the cut ends of the two plantar arteries should always be seen, and not the single mouth of the posterior tibial. In the former case the surgeon is certain that the main vessel is divided below the internal calcanean branch.

put prominently forward by Scotch surgeons. 1. The amputation is not suited for cases of disease, except of distinctly traumatic origin in young healthy subjects. 2. Occasionally the sawn os calcis fails to unite, causing either a kind of movable joint or necrosis. 3. It is said by some that the stump is more difficult to fit with an artificial foot.* The first two objections are undoubted, but I think that they are quite outweighed by the *Advantages*: 1. No dissection of the heel-flap is needed. 2. The blood-supply is less interfered with. 3. The stump is firmer and more solid. 4. The stump is longer by 1 or $1\frac{1}{2}$ inch, often more.† 5. The stump does not go on wasting, as is the case after a

FIG. 374.

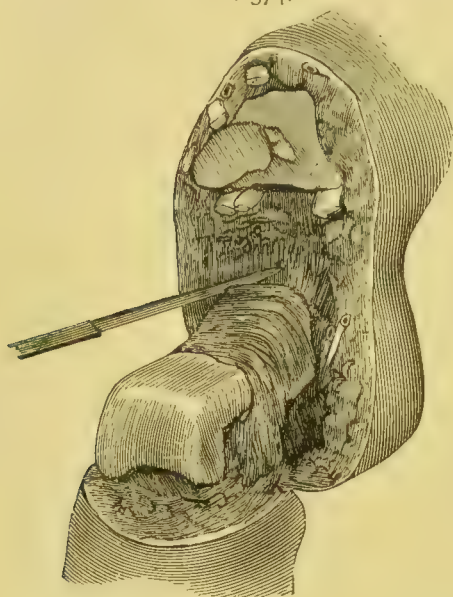


FIG. 375.



Compare with Fig. 370.

Syme's amputation.‡ 6. Dr. Hewson (*Amer. Journ. Med. Sci.*, 1864, pp. 121, 129) has pointed out that, in a Pirogoff, the origin and insertion of the gastrocnemius being both intact, the combined movements of the knee and ankle are preserved, as in running, &c.

Operation.—The position of the patient's foot and the surgeon being as at p. 1236, an incision is made, straight across the sole, from the tip of the external malleolus to a point $\frac{1}{2}$ inch below the internal one.§ This incision goes right down to the bone. Its

* Prof. Macleod thinks that the presence of the heel is here "a great drawback, and that the back of the heel, not the firm plantar pad, is what comes in contact with the ground." See the remarks p. 1242.

† Dr. Hewson (*loc. infra cit.*) gives the shortening after a Pirogoff as from 1 to 2 inches; that after a Syme as $2\frac{1}{2}$ to 3 inches.

‡ The continuance of this wasting is shown by the hospital patient being for some time obliged to stuff the socket of his elephant-boot with a sock. It is not intended by this to depreciate the value of a Syme's stump. Every surgeon knows how much good, lifelong work the heel-flap is capable of, however much it shrinks, so long as it has healed.

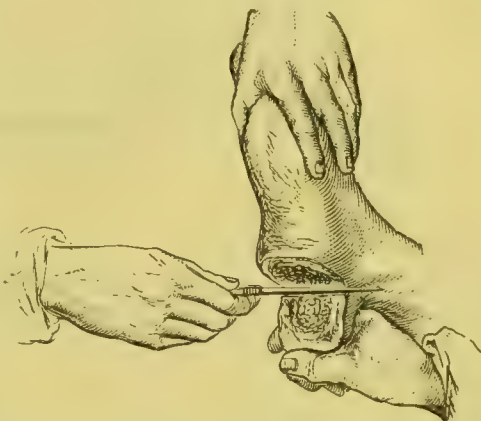
§ *I.e.*, not pointing backwards.

horns are then joined by a transverse cut across the front of the ankle. The lateral ligaments are now severed, care being taken to cut inside the malleoli and to divide the posterior tibial artery as long as possible—*i.e.*, below its origin into the two plantar—and not to prick it after it is divided. With a few touches of the knife at either side of the astragalus, aided by twisting of the foot from side to side and forcible bending of it downwards, the non-articular part of the upper surface of the os calcis comes into view (Fig. 374). A groove is now cut through the fatty tissue and the periosteum, and the saw applied just in front of the tendo-Achillis, obliquely (p. 1242) downwards and forwards, care being taken to bring it out through the incision in the heel. The foot being removed, the soft parts around the bones of the leg are carefully cleared to a level just above the tibial articular surface and the malleoli. The saw is next applied in the reverse direction to that just given—*viz.*, from below upwards and backwards, and slightly obliquely.

The vessels, the tibials, anterior peronæal, and perhaps one or both malleolar having been secured, the tendons cut square, the bony surfaces are placed in contact, and, if needful, drilled with a sterilised bradawl and united with wire or stout chromic gut.*

If it is found advisable to convert the Pirogoff into a Syme, all that is needed is to divide the tendo-Achillis and to dissect out the part of the os calcis, keeping the knife close to the bone.

FIG. 376.



Modifications of Pirogoff's

Amputation.—One of the chief of Pirogoff's amputation as modified by Dr. E. these is that introduced by **Dr. E. Watson.** (Smith and Walsham.)

Watson (*Lancet*, 1859, vol. i. p. 577).

He claims—(1) That it is shorter and easier, the trouble of disarticulation being avoided. (2) That it is less likely to damage the posterior tibial artery. (3) That it does away with one of the chief difficulties in a Pirogoff's amputation for injury—*viz.*, the want of purchase over the smashed parts while the os calcis is being sawn through.

Operation.—The operator, standing as before, having cut across the sole from the tip of one malleolus to the corresponding point (p. 1236) down to the bone, introduces a small Butcher's saw, or one with a narrow blade, into this wound, and saws off the posterior part of the os calcis by carrying his section upwards and backwards. This and the heel being now retracted by an assistant,

* If the patient is young and healthy, this step is not absolutely needful. I would recommend it in other cases. Thus I have made use of it in a Pirogoff's amputation for inveterate infantile paralysis, with excellent results. If wire be used, it must be left long. A little ether will probably be needed when the wire is removed.

the surgeon, resuming his knife, cuts upwards behind the ankle-joint between the sawn bones. The ends of the first incision are now joined by one passing between them, the skin being pulled up a little and the tendons and vessels severed down to the tibia and fibula just above the ankle-joint. Lastly, these bones are sawn through in a slanting manner by directing the saw from before backwards and downwards.* While the bones of the leg are being sawn, the heel-flap should be held well up against the back of the leg to keep it out of the way.

Modifications by Sédillot, Gunther, and Le Fort.—It is obvious that if the bones are divided as advised by Pirogoff—*i.e.*, the os calcis vertically downwards and the tibia and fibula transversely, the patient, when the bones are

FIG. 377.

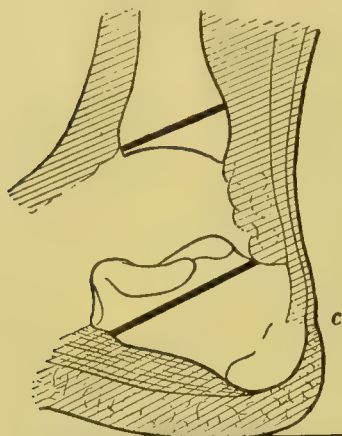
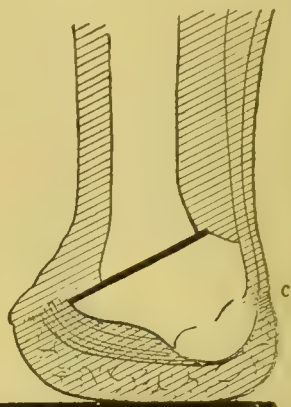


FIG. 378.



Modifications of Pirogoff's amputation by Sédillot and Gunther. (Farabeuf.)

united, will come to walk, not upon the thick fibro-fatty cushion under the tuberosities of the os calcis, but upon the thin skin over the insertion of the tendo-Achillis. To obviate this **Sédillot** and **Gunther** have advised the very oblique section of the bones shown in Figs. 377 and 378. **Pasquier Le-Fort** goes still farther and saws through the os calcis, horizontally, parallel to its articular surface, the bones of the leg being also sawn horizontally. Sir W. MacCormac thus describes the chief steps of the operation, *Surg. Oper.*, pt. ii. p. 237. The incision in the soft parts is commenced three quarters of an inch below the external malleolus and continued forwards as far as the anterior third of the calcaneum. Having reached this point the knife describes a curve across the dorsum of the foot, whose anterior convexity corresponds to the astragalo-scapoid articulation. When the knife reaches the inner border of the foot it is made to pass backwards, and stops one inch in front of and below the inner malleolus. A slightly curved plantar flap is then made which passes transversely across the sole of the foot and rejoins the first incision below the external malleolus. The tibio-tarsal joint having been next opened, the upper margin of the os calcis is exposed and the saw made to traverse the bone horizontally forwards. The remaining connections are then divided.

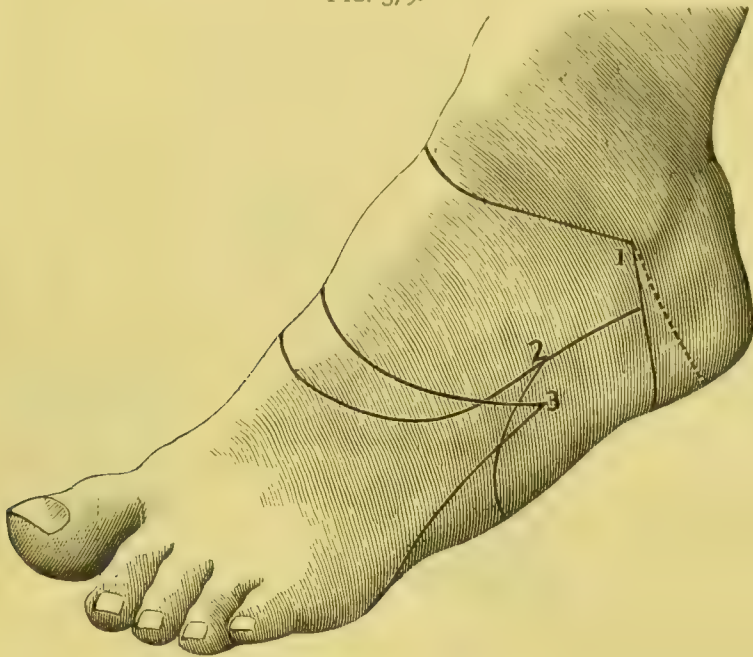
SUB-ASTRAGALOID AMPUTATION (Figs. 379-381).

This operation consists, the soft parts being divided as at Fig. 379 or 380, in opening the astragalo-scapoid joint from the dorsum, and the astragalo-calcanean

* It will be noticed that the direction of the bone section above given by Mr. Watson is contrary to that usually taught.

of which the interosseous ligament can only be divided by introducing the knife-point from the outer side. The whole foot is then removed in one mass with the exception of the astragalus, which is left mortised in between the tibia and fibula. When the stump is healed, this bone should rest upon the ground by its inferior surface. If, however, the stump should be pulled up by the tendo-Achillis and other cut muscles taking on a firm attachment, it will be the head of the astragalus alone which will rest upon the ground and transmit the weight of the body. While this has the advantage of diminishing the shortening of the limb, it has

FIG. 379.



1. The incisions in Pirogoff's amputation. The dotted line shows the direction of the plantar incision in that of Syme. 2. The incisions in sub-astragaloid; and 3. Those in Chopart's amputation.

the grave inconvenience of narrowing the basis of support, and of bringing the weight of the body upon that part of the stump where the cicatrix is necessarily found.

This amputation, very rarely practised in England, has, with that of M. Tripiier (p. 1261), largely replaced that of Chopart in France. The majority of English surgeons have, I believe, had reason to be satisfied with Chopart's amputation, in spite of the objections brought against it (p. 1258). The following account is taken from Dr. Stimson, *Man. of Oper. Surg.*, p. 113.

"The guides to this operation are the tip of the external malleolus and the head of the astragalus. The joint must be entered from in front on the fibular side, and the strong interosseous ligament which forms the key to the articulation must be divided, step by step, from before backwards and inwards. The posterior tibial vessels must be carefully avoided.

"Beginning at the outer side of the heel nearly 1 inch below the tip of the external malleolus, an incision extending through to the bone is carried straight forward to the base of the fifth metatarsal bone, thence curving forwards across the dorsum of the foot to the base of the first metatarsal, thence obliquely backwards and outwards across the sole of the foot and around its outer border, rejoining the first horizontal part of the incision at the calcaneo-cuboid joint. The soft parts must be separated from the outer surface of the calcaneum and

cuboid with division of the peronæal tendons, the dorsal flap dissected back to the head of the astragalus, and, on the inner side, beyond the tubercle of the scaphoid, thus dividing the tendon of the tibialis anticus and the anterior portion of the internal lateral ligament. The interosseous ligament can then be easily reached by depressing the toes, passing the knife between the astragalus and scaphoid, and cutting backwards and inwards along the under surface of the former. The soft parts on the inner side are then separated from the calcaneum, injury to the vessels being avoided by keeping close to the bone between it and the tendons of the flexor communis, the foot depressed, and the tendo-Achillis

FIG. 380.



Sub-astragaloid amputation (right foot) by large internal and plantar flap. (Farabeuf.)

FIG. 381.



Sub-astragaloid amputation (left foot) by large internal and plantar flap. (Farabeuf.)

divided. This last is a very difficult part of the operation, and great care must be taken to keep the edge of the knife close to the bone so as not to cut through the skin. The posterior tibial nerve should be dissected out and cut off as high as possible, so that it shall not be pressed upon in the stump."

M. Farabeuf advises an internal and plantar flap, whose nutrition is guaranteed by a very large base. This is the flap of Roux (Figs. 371, 385), made considerably longer in front. The incision passes parallel to the outer border of the foot, a full finger's-breadth below the external malleolus, as far as the tuberosity of the fifth metatarsal, then across to the scapho-cuneiform articulation, and the extensor proprius pollicis tendon. Then it descends over the middle of the inner border of the foot, as far as the centre of the sole. Here it begins to turn back along the outer border of the foot, as far as the posterior extremity of the os calcis, where it joins the starting-point. Fig. 385 shows the dissection of this flap in the case of the right foot: the left hand of the operator raises and protects the soft parts in front of the knife, which is kept parallel to the vessels and tendons lying under the sustentaculum tali. Fig. 386 shows the flap before it is sutured.

EXCISION OF THE ANKLE.

This operation is one of very disputed value, and thus rarely performed.

Objections: (1) Disease here is often associated with disease of the tarsus. (2) Even if the wound heals, the foot left is often of little use. (3) Syme's

amputation affords not only a radical cure, but a most excellent stump. This may be imperilled by a previous excision of the joint.

Indications.—These, which are very few, must be considered separately, according as they fall under the heading of : A. *Disease.* B. *Injury.*

A. *Disease.*—(1) The patient must be young and healthy, with no evidence of other tubercular disease, or of phthisis or syphilis. (2) The disease should be of traumatic origin—*e.g.*, following a sprain—and (3) limited to the bones which form the joint, the whole astragalus being taken away if needful. To another class of cases in which this operation has been too often performed—*viz.*, where the patient's health is reduced by discharge, pain, hospital air, &c., where other tarsal bones are involved—this excision is not applicable ; it is here much severer than amputation, and leaves the patient most liable to recurrence.* Quite a separate instance of excision in disease may be occasionally practised in advanced cases of infantile paralysis. Here the ankle may be excised (by a transverse incision) some time after the knee has been submitted to the same operation, in order to give a firm basis of support in good position, instead of a flail-like limb which shuts up at the knee and ankle (p. 1188).

The chief points in excision of the ankle-joint which have been raised as objections to the operation are: (1) The difficulty of free exposure of the parts to be dealt with ; (2) The frequency with which other bones are diseased. Thus, Mr. F. Jordan † strongly objected to the operation on the ground that the astragalus is not a long bone with an epiphysis in which the chief disease may lie, but a short bone consisting of a mass of cancellous tissue throughout which the disease is more or less diffused. This objection may be answered by the fact that if the disease in the astragalus is found not to be limited to the upper articular surface, it will in no way interfere with the results if the whole bone is removed.‡ And this fact will meet another objection to excision of the astragalus made by Prof. Syme—*viz.*, that the frequency with which disease of the astragalus originates on the under surface of this bone (*i.e.*, between it and the os calcis §) calls rather

* In Mr. Holmes' words (*Syst. of Surg.*, vol. iii. p. 766), in the first class of case "the inflammatory softening or suppuration does not usually extend far from the neighbourhood of the joint originally implicated, and, after the removal of the diseased bone, the parts take on a healthy action and become rapidly consolidated. In strumous disease, on the other hand, inflammatory softening, if not diffused suppuration, often exists in the tarsal bones or bones of the leg in parts not exposed to view in the operation ; and, in patients labouring under general constitutional affections, the parts operated on, instead of consolidating, usually soften, and after a long and exhaustive suppuration the bones are found carious, leaving no resource except amputation, and that sometimes under unfavourable circumstances."

† *Lancet*, 1867, vol. i. p. 729.

‡ Mr. Holmes, whose experience of this operation is a large one, advises (*Brit. Med. Journ.*, 1878, vol. ii. p. 875) that the whole of the astragalus should always be removed, for these reasons—(1) As it is often softened to a considerable depth, mere removal of its articular surface will often leave disease behind ; (2) in patients low in health, or of strumous constitution, the violence done by the saw may prove the starting-point of renewed caries ; (3) the bones of the leg unite quite as firmly to the exposed cartilaginous surfaces of the os calcis and scaphoid as they do to the sawn surface of the astragalus ; (4) the shortening is not appreciably increased ; (5) the difficulty of the operation is lessened (p. 1246).

§ Instances of extensive removal of the bones of the tarsus are given at pp. 1252, 1253.

for amputation than excision. (3) The difficulties of securing afterwards a splint which will combine the three following essentials—viz., (a) Sufficient rest; (b) Sufficient exposure for needful change of dressings; (c) The possibility of antiseptic treatment. Two excellent but too little known splints are Esmarch's bracket-splint, and the iron splint moulded to the back and front of the leg, and front and sole of foot, and covered with india-rubber, introduced by Mr. Paul of Liverpool. This is a model of combined usefulness and simplicity. Both are secured in place with plaster-of-Paris. But if, in addition to much of a cavity to fill up, any tendency to œdema remains, a back and two side splints—all three being interrupted—are, in my opinion, preferable.

B. Injury.—In a young, healthy patient, where the vessels and nerves are mainly intact, where the mischief is limited to the ends of the bones, an attempt to save the limb by excision, partial or complete, is abundantly justified. The steps given at p. 1229 for the antiseptic treatment of compound fractures should be carefully attended to, as to the preservation of periosteum, the due providing of drainage, &c. As to gunshot injuries, Dr. Otis (*Med. and Surg. Hist. of the War of the Rebellion*, pt. iii. p. 610) thought that "the substitution of excision of the ankle-joint for amputation effected no saving of life," formal excisions being rarely successful.

Operation.—This may be either by two lateral incisions, or by a transverse one, dividing the extensor tendons, which are sutured afterwards.

Excision by Lateral Incisions.—An Esmarch's bandage having been applied above, and the parts rendered evascular as well, the foot is laid upon its inner side firmly supported on a sand-bag. An incision is made along the lower $2\frac{1}{2}$ inches of the posterior border of the fibula, and then, when it has reached the tip of the malleolus, it is carried downwards and forwards at an angle to within an inch of the base of the fifth metatarsal bone. A slight flap is now sufficiently dissected forwards to expose the bone and to clear the peronæi; these being drawn aside, the bone is divided with a narrow saw or cutting-forceps about 2 inches above the malleolus, and removed after division of the external lateral ligament. This wound is now covered with carbolised lint and the foot turned over, and a similar angular incision made along the lower 2 inches of the inner margin of the tibia, and then forwards and downwards as far as the projection of the internal cuneiform bone.* A flap being dissected slightly inwards, the tendons of the tibialis and flexors are exposed and retracted,† the knife being kept close to the bone so as to avoid the posterior tibial vessels.

The internal lateral ligament is now cut through close to the tibia, and on displacing the foot outwards the tibia and astragalus present in part at the inner wound. A metacarpal saw being next passed from the inner to the outer wound, the lower end of the tibia is sawn off sufficiently high up to secure a healthy section of bone, and no more. The astragalus is next treated similarly.‡

* The lower extremities of these incisions need not go down to the bones.

† Unless these tendons are sufficiently freed from their connection with the lower end of the tibia, difficulty will be met in everting the foot sufficiently to bring the tibia out of the wound (Hancock, *Lancet*, 1867, vol. i. p. 731).

‡ If the disease here is at all extensive, this bone should be entirely removed (p. 1245). If a section only of the astragalus is taken, much difficulty will be met in removing the upper articular surface. Thus, unless the saw be directed properly, the astragalo-scapoid or astragalo-calcaneal joints may be opened. To meet the difficulty of fixing the foot the heel should be held in the left hand, and the upper surface of the astragalus is pressed against the cut end of the tibia, while an assistant holds the leg firmly on, and a little over, the edge of the table (Porter, *Brit. Med. Journ.*, 1878, vol. ii. p. 792).

all the articular cartilage being removed. Any soft patches of bone are next gouged, and pulpy material snipped away from the synovial sheaths of the tendons, &c. All sinuses are next scraped out or laid open. The only vessels which will require tying are some branches of the peronæal and the malleolar, none of any importance being divided. Very few, if any, sutures should be used, so as to allow of very free drainage.

Excision by Transverse Incision.—The parts being rendered evascular, an incision is made transversely across the front of the ankle-joint from the tip of one malleolus to the other. The extensor tendons being divided, the anterior and lateral ligaments severed, the end of the tibia is exposed, a way cleared for the saw just above the malleoli, and a slice removed. The upper articular surface of the astragalus is then treated in the same way, the peronæi and flexor tendons being drawn aside while the bones are sawn. Any dead bone is gouged away and pulpy tissue removed, as mentioned above. Hæmorrhage having been arrested, several of the divided tendons—*e.g.*, the tibialis anticus, two or three of the extensor tendons—are sutured with chromic gut or carbolised silk.

In either of the above operations every care must be taken to preserve the periosteum, especially where this is softened and loosened.

A suitable splint is always a difficulty in these cases. On the whole, a back splint and foot-piece, and two side splints, all being padded with gauze, will be found most suitable for the first ten or fourteen days; the side splints, being secured with straps and buckles, readily admit of removal so as to change the dressings. If all the disease has been taken away, and due drainage provided, the dressings will need changing very infrequently. After the first fortnight, the limb may be put up in one of Esmarch's or Paul's splints, secured with plaster-of-Paris (p. 1246). Another arrangement which answers well with a quiet patient is to put up the limb on its outer side, with the knee flexed, on an outside angular splint interrupted opposite the wound, the splint being duly supported with pillows. If the external wound is left freely open, this method gives good drainage.

ERASION OF ANKLE-JOINT.

Indications.—The above operation should be employed when the following conditions co-exist: A young subject with good power of repair; tubercular disease limited to the ankle-joint; absence of disease in other joints or viscera. Where these conditions do not co-exist, a Syme's amputation is in my opinion to be unhesitatingly preferred, owing to the excellent stump which it gives: where disease has been left here too long, and where the tibia is involved, and the soft parts undermined and riddled with sinuses and the tendon sheaths involved high up, an amputation of the leg is required.

Erasion of the ankle-joint will obviously be of limited source, as in many cases several of the tarsal bones are involved in addition to the ankle-joint, and when the subject is not young, failure of an erasion or excision of the ankle-joint imperils greatly the success of a Syme's amputation.

Operation.—As in excision of the ankle-joint the different methods class themselves under two heads: (A) **A transverse incision.** (B) **Lateral incisions.** (A) **Erasion by a transverse incision.**—G. A. Wright of Manchester, who gave such a healthy impetus to erasion of joints, thus describes a case operated on as long ago as 1882 (*Diseases of Children*, Ashby and Wright, p. 633). The child was eight years old. The joint was opened by a transverse incision across the front of the joint, dividing all the extensors, &c., much pulpy synovitis existed with subchondral caries; all the pulpy tissue, as well as the loosened cartilage were removed as far as possible. The tendons were stitched together with catgut and the wound closed. No attempt was made to unite the

nerve, the anterior tibial artery was twisted. The wound was very slow in healing, but three years later the child's condition was as follows: "foot sound and well, but the toes are somewhat pointed, and he 'throws' the foot in walking. He gets about well with a boot and without any support. A good deal of new bone-formation about line of incision, but some mobility."

Mr. W. A. Lane has extended the above method by a transverse incision, as follows (*Clin. Soc. Trans.*, vol. xxxvii. p. 15): "An incision is made from the anterior margin of the tip of the inner malleolus across the front of the ankle, then backwards immediately below the external malleolus around the heel to within a measurable distance of the flexor longus hallucis, everything being divided down to the bone. The only structures about the ankle-joint which are left uncut are the internal lateral ligament, the tendons of the flexor longus digitorum and tibialis posticus, the posterior tibial vessels and nerve, and the superjacent connective-tissue and skin. The interior of the ankle-joint can then be exposed as readily as one separates the pages of a book, and the whole of its synovial membrane exposed. The narrow prolongation of synovial membrane upwards between the tibia and fibula is shown more completely by dividing the inferior interosseous and anterior tibio-fibular ligaments." Some care is required in putting up the limb in plaster after the operation, that the fibula does not fall back a little from its normal position. Two cases are given in which the after-condition of the foot was most satisfactory, but the length of time in which these patients had been watched is not given.

(B) **Erasion by Lateral Incisions.**—Mr. Clutton, believing that such a very free division of the structures around the ankle-joint is not necessary in erasion, has recently advocated this method (*Trans. Med. Chir. Soc.*, vol. lxxvii. p. 101). "The method* of procedure was by a series of vertical incisions round the ankle-joint, through which a sharp spoon, and even a finger, could be introduced. Four incisions, one in front and another behind each malleolus, avoiding ligaments and tendons by freely opening the joint, were generally employed. If traction was made on the foot the finger could always be introduced to examine the joint surfaces after the use of the sharp spoon. The nozzle of an irrigator with a full stream of aseptic fluid was kept constantly going through one or other of the openings round the joint. The introduction of the finger was especially useful in hunting for soft patches of tubercular granulation-tissue, for then the sharp spoon could be introduced to that spot. In most cases the cartilage came away and the bone beneath was attacked with more or less vigour, according to the condition of the fragments which were removed. An objection has been raised to this method of procedure, namely, that the surgeon cannot see the condition of the structures upon which he is operating. But if the finger is used as described above, and when the bone is being scraped, the fragments are carefully examined, there is really little difficulty in arriving at a conclusion as to when enough has been done. The consistence of the bone and its resistance to the action of a sharp spoon is not alone sufficient, for in the neighbourhood of a diseased articulation the bone is often rarefied without being invaded with tubercle." A copious dressing was applied, and over this a plaster of Paris splint was put on with an iron bar at the back, and windows at each side. When the patient was able to get up, a knee-rest was ordered to be used for many months.† Any persistent sinus must be scraped out without delay (p. 1199).

* As stated by Mr. Clutton, an exactly similar method of operating is described by Bruns (*Münchener Med. Woch.*, 1891).

† Free movement in the medio-tarsal joint often made up for any ankylosis of the ankle-joint.

Mr. Clutton gives 6 cases * which have been treated by him by erosion with longitudinal incisions. As to the results Mr. Clutton is certainly correct in claiming that they "are sufficiently encouraging to make one think that more effort should be made in the conservative treatment of the joint than appears at present to be the practice of operating surgeons."

As to which of the two methods is the best it is clear that good results can be secured by either. Speaking for myself only, I am of opinion that in most hands a transverse incision, prolonged as freely as needful, will give the best exposure of the joint, and thus facilitate the eradication of all the diseased tissue which is so essential in dealing with tubercular joints (p. 1190).

EXCISION OF BONES AND JOINTS OF THE TARSUS.

Before considering these separately, I would invite attention to the following **practical points**:

i. Those cases are the least hopeful in which there is no history of injury, in which there is evidence of a tubercular constitution, or perhaps of disease dating to an exanthem and coupled with the above constitution; cases in which the patient is wan and sickly with long lasting pain and sleeplessness; cases in which the parts are much swollen, dusky red, and glossy, with sinuses numerous or excavated, giving vent to watery, ill-smelling discharge—all points denoting a disease that is not limited to one joint or to few bones. ii. Mere laying open, and, still more, injection, of sinuses where there is disease of the tarsus is absolutely useless in most cases. iii. When a patient is under care for caries of the foot, his lungs should always be carefully examined before operative treatment is undertaken. iv. When the amount of disease present is being estimated, it must be remembered that patients, especially children, will often use their feet with much freedom, limping, even bearing their weight on their toes with the aid of a crutch, though all the time extensive disease is present. v. That before an operation, the parts should always be rendered absolutely evascular by the use of Esmarch's bandages,† and that thus the limit of the disease should be defined as accurately as possible. vi. Subperiosteal excision is only advisable in the case of single bones where the periosteum is already thickened and loosened, and that in other cases it is not of such great advantage as to justify any considerable prolongation of an operation. vii. Strict antiseptic precautions should be made use of wherever this is possible, because—(a) Prolonged suppuration will exhaust a patient, whose powers

* Some of these go back to 1887–1889.

† This is disputed by some. I strongly advise it. The free oozing after this method may be met by tying any vessels which are seen in the absolutely dry wound, and then usually plugging this with strips of iodoform gauze, wrung out of carbolic acid lotion, 1 in 20, bandaging firmly over well-applied dressings before the Esmarch's bandage is removed, and giving sufficient morphia in the first twelve hours. This dressing will seldom require removal for several days, when the strips must be thoroughly soaked before removal.

are already sufficiently handicapped by disease and operation; (b) Suppuration will cause destruction of the periosteum, and thus fresh caries and necrosis; (c) Interference with inflamed bones may, if sepsis result, easily cause osteo-myelitis and pyæmia. viii. When the question arises between excision and amputation, if the powers of repair have been duly considered, the question of time and the rank of life should also be remembered. Thus, after an extensive excision, six months will probably be required before the foot can be used, but only three months after an amputation. The time in the first case may after all be wasted, a point of much importance, when the question of schooling, learning a trade, &c., have to be considered. ix. No use of a foot can be permitted after an operation till firm consolidation is obtained. x. If pulpy mischief persist after an operation, the sharp spoon must be freely used, together with laying open sinuses, snipping away of undermined skin, &c. If all carious bone has been removed, the above steps may be repeated again and again here, as in the knee, with ultimate success.

EXCISION OF THE ASTRAGALUS.*

Indications.—These will be for A. *Disease*, B. *Injury*. Both are rare.

A. *Disease*.—(1) Caries of the bone, especially when comparatively recent and of traumatic origin in a young and healthy patient, and when the disease is found to be limited to the upper surface. (2) In disease of the astragalocalcanean joint, where it is thought, from the position of the sinuses, &c., to be more advisable to expose this joint by removing the astragalus than the os calcis. (3) Talipes: in inveterate resistant cases, especially of the paralytic variety (p. 1256).

B. *Injury*.—(1) Primarily. (a) In simple dislocation of the astragalus not reducible with the aid of anæsthetics and tenotomy of the tendo-Achillis and the tibials or extensors, if it seem certain that the skin will slough. (b) In compound dislocation of the astragalus when the bone is too far displaced or comminuted to admit of replacement, and when the condition of the soft parts, vessels, and tendons does not call for amputation. (2) Secondly, when the foot is useless and painful. In these cases, especially, strict antiseptic precautions must be taken and free drainage provided.

Operation.—This may be performed by two lateral or a transverse incision, with suture of the tendons. On account of the freer exposure given, I prefer the latter. The parts having been rendered evascular, the bone is exposed by an incision crossing the dorsum between the malleoli, as in Syme's amputation; the tendons

* A good instance of the occasional value of this operation has been given by my old friend George A. Wright (*Pendlebury Abstracts*, 1884, p. 124). The case was one of severe talipes valgus, due to infantile paralysis of a year's standing. The reaction of the muscles to Faradism was extremely poor. "The deformity clearly depended on a partial sub-astragaloid dislocation." The bone was removed by an incision along the inner border of the tibialis anticus, and a shorter one meeting this between the tibialis anticus and posticus. No tendons were cut; one small vessel required twisting. The foot could be inverted into good position after removal of the bone. Twelve months later the child could walk painlessly and much more freely, without eversion, and with a good arch.

are cleanly cut, and the astragalus exposed. At this stage all that may be required is to remove a sequestrum from the upper surface of the neck of the bone. The ligaments must be divided by carefully keeping the knife close to the bone * while this is twisted out in the grasp of lion-forceps, aided, if needful, by the levering movements of an elevator.† If the astragalo-calcanean joint is found diseased, this must be now attended to with chisel, gouge, and sharp spoon. The scaphoid is next examined. All pulpy material having been removed, hæmorrhage is arrested,‡ the chief tendons sutured, and the centre of the wound closed, the sides being left open for drainage.

EXCISION OF THE OS CALCIS.

Practical Remarks.—Disease here is not very infrequent, and often remains limited to this bone for a long time. It may commence in one of three sites—viz., (a) the posterior epiphysis, which, not appearing until the tenth year, does not unite till between the fifteenth and nineteenth years; (b) the body of the bone; (c) the calcaneo-astragaloid joint, either *de novo*, or as an extension of the last. The diagnosis of primary disease in this joint is often difficult; thus the swelling and position of the sinuses recall disease of the ankle-joint. The pain is usually greater than in ordinary disease of the os calcis itself, and the foot is sooner disabled. With an anæsthetic, the ankle-joint is found free, and probes introduced by sinuses may pass towards the level of the upper surface of the os calcis (known by the tubercle for the extensor brevis).

Operation.—The parts being rendered evascular and the foot firmly supported on its inner side at the edge of the table, an incision§ is made with a strong-backed scalpel, commencing at the inner edge of the tendo-Achillis, and passing along the upper border of the os calcis (*vide supra*) along the outer border of the foot as far as the calcaneo-cuboid joint, which lies midway between the outer malleolus and the fifth metatarsal bone. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. Another incision is then to be drawn vertically across the sole, commencing near the anterior end of the first and terminating just short of the inner surface of the os calcis, beyond which it should not extend for fear of wounding the posterior tibial vessels. The bone being now exposed by throwing back the flap, the calcaneo-cuboid joint is first found and opened. The peronæi must be dissected out|| and drawn aside with a blunt hook. The astragalo-

* Especially at the back and on the inner side.

† Care must be taken, in using this, not to bruise any soft bone which is used as a fulcrum.

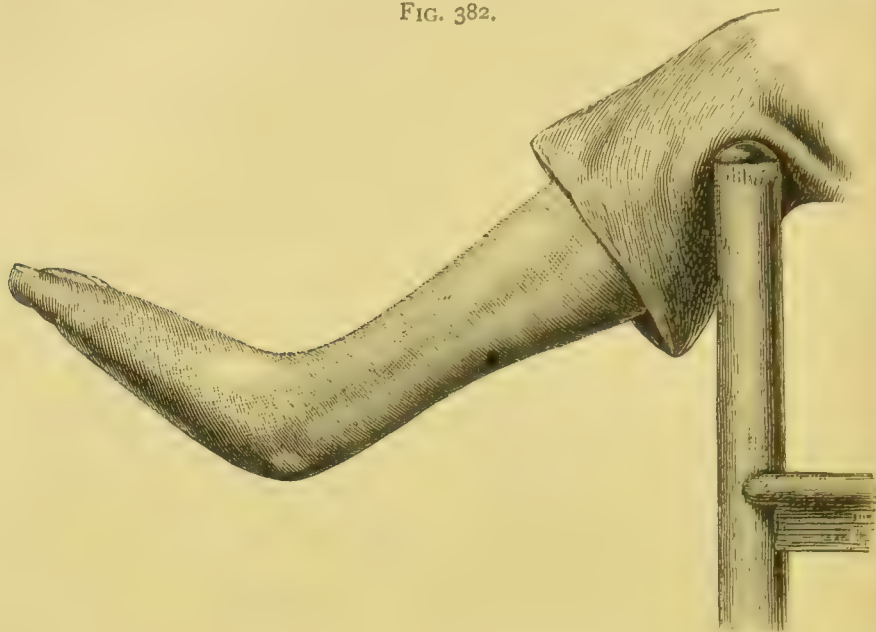
‡ The dorsalis pedis should be secured, and oozing met by plugging the wound with strips of iodoform gauze wrung out of carbolic acid, 1 in 20, the ends of the strips being brought out at the sides, or the surgeon may rest content with applying sufficient dressings before he removes the Esmarch's bandage.

§ The above incision is taken from Mr. Holmes' article, *Syst. of Surg.*, vol. iii. p. 771. A still better one is that advised by Farabeuf (*Man. Oper.*, p. 759). A horseshoe-shaped incision is made round the heel, beginning at the calcaneo-cuboid joint, dividing the tendo-Achillis and ending on the inner aspect of the foot, external to the posterior tibial vessels and nerves. To this incision a short vertical one is added, running up along the outer side of the tendo-Achillis. By turning aside the flaps thus marked out the bone is most thoroughly exposed.

|| Mr. Holmes (*loc. supra cit.*) says that he has always divided these without ill effect. Care must be taken in drawing them aside, for, if this is done too vigorously, one may slough, as happened to me in one of my cases.

calcanean joint is next attacked, and the close connection between the bones at this point constitutes the principal difficulty of the operation, unless the joints have been destroyed by disease. This difficulty can best be met by grasping the bone firmly with lion-forceps, and wrenching it backwards and outwards, aided

FIG. 382.



Foot two years after removal of os calcis in a child. The foot is flat but very serviceable. As will be seen from the state of the calf, the tendo-Achillis has taken on a fresh attachment in the detached periosteum, and has been well employed.

by levering movements of an elevator, and a knife-point kept very close to the bone. Especial care must be taken on the inner side to avoid the vessels. The bone being removed, the gap is lightly plugged with gauze, and the dressings applied before the Esmarch's bandage is removed.

The question of preserving the periosteum has already been referred to, p. 1249. Some good cases of excisions of tarsal bones are recorded by Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 769 *et seq.* ; and *Surg. Treat. of Children's Dis.*, chap. xxvi.

OPERATIONS FOR MORE COMPLETE TARSECTOMY.

It is scarcely worth while to give directions for the removal of other single bones—*e.g.*, the scaphoid and cuboid—as these are rarely diseased alone, and, if this should be so, their removal is easy.

The operations of Mickulicz and of Dr. P. H. Watson will be described to meet those cases where more extensive disease is present, and where the patient's age and condition justify a trial of these severe operations instead of amputation. In the very few cases which call for these operations Watson's is to be preferred, as it leaves a foot at right angles with the leg.

Operation of Mickulicz.*—The object of this operation is to procure an artificial pes equinus, and to preserve the toes and metatarsals, these being brought into a straight line with the leg and the toes bent at a right angle, so

* The account of this is taken from a paper of Sir W. Mac Cormac (*Lancet*, May 5, 1888), four figures accompanying this. Mickulicz's paper will be found in *Langenbeck's Arch.*, 1881, Bd. xxvi. S. 191.

that the patient walks on the ends of the metatarsal bones covered by the thick pads of tissue which invest them ; a broader surface of support is provided than after Syme's or Pirogoff's amputations, and there is some elasticity of the foot left. I do not recommend this operation, and only introduce the account from my respect for the surgeon whose name it bears. The result is obtained at far greater cost and risk than that by a Syme's amputation, and is, in my opinion, of very doubtful superiority. Mr. Bland Sutton (*Lancet*, 1893, vol. ii. p. 1513) brought before the Medical Society the skeleton of a foot three years after the performance of Mickulicz's operation. The artificial pes equinus had been produced by Sir W. Mac Cormac in a girl, aged eighteen, the subject of infantile paralysis. In spite of the anatomical success of the operation the foot was of little service in progression, causing the girl much pain and inconvenience, and Mr. Sutton removed the leg by amputating through the knee-joint.

Sir W. Mac Cormac's patient was aged fifteen, and the disease dated to a sprain of the ankle. On the lad's admission the swelling and sinuses pointed to disease of the os calcis ; later on, the ankle-joint became involved. Amputation being refused, Sir W. Mac Cormac operated thus: "The patient was placed in the prone position. If it be the right foot, the knife is introduced on the inner border of the foot, just in front of the scaphoid tubercle, and a transverse incision, extending to the bone, is made across the sole to a point a little behind the tuberosity of the fifth metatarsal. On the left foot the direction of this incision will be reversed. From the inner and outer extremities of the wound incisions are prolonged upwards and backwards over the corresponding malleolus, and their extremities united by a transverse cut across the back of the leg, down to the bone, at the level at which it is to be sawn, usually immediately above the joint surface of the tibia. In cases where a larger removal of the tibia and fibula is required, the lateral incisions must be more oblique, and the posterior transverse cut made at a higher level. The ankle-joint is now opened from behind, the disarticulation completed, and, after flexing the foot, the soft parts are carefully separated in front until the medio-tarsal joint is reached, through which disarticulation is effected as in Chopart's amputation. The heel portion of the foot, consisting of the astragalus, calcis, and the soft parts covering them, is thus removed. The articular surfaces of the tibia and fibula, with the malleoli, are now sawn off, as well as those of the cuboid and scaphoid. The anterior portion of the foot remains connected with a bridge of soft parts. The blood-supply appears to be ample, for almost directly after the operation blood issued freely from the distal ends of the divided plantar arteries. All hæmorrhage having been arrested, the foot was brought into a straight line with the leg, and the cut surfaces of the bone were sutured together with kangaroo tendon. The attempt to discover and unite the divided ends of the posterior tibial nerve failed, on account of the sodden condition of the soft parts. Suitable dressings and a plaster-of-Paris splint were applied, the toes being brought into a position of complete dorsal flexion."

The boy made an excellent recovery. Firm bony union took place. In about a month sensibility began to return in the sole, and gradually became more complete. The toes were mobile.*

Operation of Watson.—This is adapted to cases where the medio-tarsal articulation is involved, the importance of which, from the number of bones and the complicated synovial membrane, is well known (p. 1262). In other words,

* The patient was shown to the Medical Society more than a year after the operation. "He walked up and down the room, both with and without his boot, with great ease and evident satisfaction to himself. The union is quite solid, and he now attends to his daily work without any inconvenience."

the disease should be situated between the bases of the metatarsal bones in front and the os calcis and the astragalus behind. The parts being rendered evascular, incisions 3 to 4 inches long are made, on the outer side, from the centre of the os calcis to the middle of the fifth metatarsal bone, and on the inner from the arch of the astragalus to the middle of the first metatarsal. The soft parts are carefully dissected off from the dorsal and plantar aspects of the foot by means of these incisions, the left thumb being kept between the point of the knife and the bones. With a curved probe-pointed bistoury the joints between the astragalus and scaphoid, and os calcis and cuboid, are opened up, and, a saw being passed between the plantar soft parts and the metatarsal bones, these are cut through from below upwards. The diseased bones being removed, the wound is firmly plugged and pressure applied with gauze pads and bandages before the tourniquet is removed. That this operation, though little known, is an excellent one in Dr. Watson's hands is shown by the fact that five out of his six cases did well. It must be remembered that it is an operation in the dark, and one that may involve a good deal of damage to soft parts, owing to the amount of disease which has to be removed by somewhat limited incisions.

REMOVAL OF TARSAL BONES FOR INVETERATE TALIPES.

Indications.—Cases which deserve the above epithet of inveterate, in which tenotomy, syndesmotomy and forcible manipulation have been thoroughly tried; cases in which there is evidently confirmed alteration in the shape of the bones—*e.g.*, in talipes equino-varus—such rigidity that the position of the foot cannot be possibly altered, the astragalus projecting outwards on the dorsum, and the scaphoid so displaced that it almost touches the internal malleolus; where the patient walks on the outer border of his foot, and large bursæ have formed over the cuboid; and where the patient is prevented from earning his livelihood. Finally, the surgeon must feel assured as to his power of conducting the case antiseptically.

The chief operations for inveterate or resistant talipes are—
 (i) **Complete section either by open incision**, Phelps's operation or by subcutaneous section; (ii) **Removal of the astragalus**; (iii) **Cuneiform tarsectomy**. Before they are described I would impress most strongly upon my younger readers the cardinal importance of the following: (1) Relapses will follow after any operation, however complete and severe at the time, unless the patient is kept under observation sufficiently long for the surgeon to feel certain that the case is certain. (2) Relapses depend upon either the patient being too soon removed from supervision, or upon the surgeon saying prematurely that the cure is complete. (3) No cure is complete until the patient has been

* Either by the hands or by the aid of Thomas's wrench. An excellent account of the use of this—in fact one of the very best descriptions of the treatment of talipes in the English language—is given by Mr. R. Jones of Liverpool and Dr. Ridlon of Chicago in the *Medical Annual* for 1896, p. 448. Another very helpful account of talipes is that given by Mr. Tubby in his recently published work on Orthopædic Surgery.

walking, under skilled observation at intervals, for a sufficient time. It is quite impossible to lay down any law or limit here. For cases after puberty—and it is to such patients that the operation to be described, chiefly refer—several years are required; for adolescents or adults at least one year is needed. The more severe the case the more care is required for the surgeon to be absolutely certain that, when walking is allowed the body-weight falls on the foot in the right position, and not unduly on the outer side, perpetuating, if even in the slightest degree, the varus. (4) While there is no routine method of operation in these cases the surgeon will, of course, secure the best results from that operation with which he is most familiar.

Phelps' Operation by Open Incision.*—The foot having been cleansed and rendered evascular is placed on its outer side, and a line is drawn from the tip of the inner malleolus to the tuberosity of the scaphoid. From the centre of this line an incision is made outwards across the inner third of the sole,† down to the neck of the astragalus on its inner side. Through this wound the plantar fascia, abductor hallucis, tibiales posticus and anticus, the long flexors, together with the internal lateral and calcaneo-scaphoid ligaments are divided. If possible, the internal plantar vessels and nerve are spared. Great force is then used to rupture the deeper ligaments and over-correct the foot. Phelps also divides the tendo-Achillis at the same time, others prefer to leave this step till a later occasion. The wound, partly sutured, is put up without drainage and must heal, partly under bloodclot, partly by granulation. The foot is maintained in the over-corrected position by plaster-of-Paris.‡

Lane's § Complete Subcutaneous Section.—Mr. W. A. Lane, believing that the later results of Phelps' operation are very unsatisfactory owing to the "absolute loss of continuity of all the soft parts in the sole of the foot," advises the following method (*Lancet*, vol. ii. 1893, p. 432): "An india-rubber bandage is applied above the knee to control the circulation, so as to prevent the free bleeding that would otherwise occur, and then, by means of a strong, long-bladed, sharp-pointed tenotomy knife, everything beneath the skin that opposes the placing of the foot in a position of moderate abduction upon the astragalus is divided. This includes the several divisions of the plantar fascia, part of the

* Mr. E. Owen strongly advocates this operation in an excellent account of it (*Med. Chir. Trans.*, vol. lxxvi. p. 89).

† Phelps originally made his incision two-thirds across the sole, but modified it owing to the tender scar which was liable to result.

‡ Mr. W. A. Lane to hasten the otherwise tedious healing puts on a large skin-graft on the second day (*Lancet*, Aug. 19, 1893). Mr. Tubby points out one difficulty in the after-treatment, and that is the tendency of the edges of the skin to become inverted over the shelving edges of the deep wound (*Orthopædic Surgery*, p. 435). From the same writer I take the following modification of Phelps' operation by Dr. W. Gardner of Melbourne, which may be useful. "A wedge-shaped plate of decalcified bone is inserted into the gap between the astragalus and scaphoid, to which bones it is wired, and by this the lengthening of the inner side is maintained until the plate is replaced by fibrous tissue. There is then a minimum of interference with the tarsal articulations, and the arch of the foot is not destroyed." A better course would be to first turn up a flap of skin, as suggested by Mr. Treves, *Oper. Surg.*, vol. i. p. 764.

§ A somewhat similar operation is given by Buchanan (*Brit. Med. Journ.*, Oct. 27, 1888).

internal lateral and annular ligaments, the superior internal calcaneo-scaphoid, the inferior calcaneo-scaphoid and the long and short plantar ligaments, together with the tibialis anticus and all the tendons, vessels and nerves in the sole of the foot. This cannot be done satisfactorily through a single puncture, but I do not hesitate to make any number of punctures, only taking care that the knife is entered in such a direction that the forcible fixation of the foot in a position of abduction does not cause the wound made by it to gape. This is a matter of considerable importance, since it is frequently necessary to sew up the apertures which are made by the knife, otherwise arterial blood spurts through them on removing the tourniquet. By spending some time, and by exercising a moderate amount of skill, it is possible to divide all the soft parts opposing abduction of the foot on the astragalus and to leave the skin intact, except for the punctures produced by the tenotomy knife. After this has been done, I pass a knife between the skin and tendo-Achillis and divide it. If the foot does not become square I cut all the soft parts except the peronæi, carefully dividing the posterior ligament of the ankle-joint, which often opposes free movement of this articulation."

With regard to the above operations I am of opinion that cases severe enough to require them are best met by cuneiform tarsectomy (*vide infra*).

Removal of Astragalus.—(Lund, *Brit. Med. Journ.*, Oct. 19, 1872). A longitudinal incision* about 2 inches long and gently curved, is made over the most projecting part of the head of the astragalus from the external malleolus downwards and inwards, between the outermost tendon of the extensor longus digitorum and the peronæus tertius. The soft parts on either side of the incision having been raised with an elevator, the ankle and astragalo-scaphoid joints are opened, the bone is loosened in its bed with an elevator while its ligamentous attachments are divided with blunt-pointed scissors. This is facilitated by drawing the bone in different directions with lion-forceps. The chief difficulties met with are: (1) the closeness with which the bone occupies its socket and the consequent readiness with which, if a sharp instrument be used to lever out the astragalus, slices of cartilage are detached from the scaphoid or malleoli; (2) division of the ligaments, especially the interosseous and the internal lateral.

Advantages.—This operation gives an excellent result in those cases in which the chief deformity is the astragalus; the cases most suitable being those of paralytic varus. A good arch and much mobility at the ankle are often preserved.

Disadvantages.—In those cases in which removal of the astragalus is not sufficient to allow of the foot being placed at least at a right angle with the leg, the external malleolus must be partially divided with bone forceps, and then the foot carried outwards, bending the malleolus backwards and outwards also (Walsham).† If this does not suffice a wedge must be removed from the tarsus. As I have not found it easy to make sure in which of these advanced cases removal of the astragalus will suffice, I generally prefer to remove a wedge at once, as involving less disturbance of the parts than two operations, and as being certain. Mr. Walsham, however, prefers beginning with removal of the astragalus. Mr. Ewens (*loc. infra cit.*) recommends tarsectomy.

Cuneiform Tarsectomy.—This operation is especially indicated in those inveterate or resistant cases of talipes where great prominence of the astragalus

* G. A. Wright (*Diseases of Children*, with Dr. Ashby, p. 687), advises an incision over the ankle-joint, from the tibialis posticus to the anticus, and another incision at right angles to the first along the inner side of the tibialis anticus.

† "When once a bone-operation has been embarked on, it is no use stopping short till sufficient bone has been cleared away to permit of the rectification of the foot. No more should, of course, be removed than is necessary, but to take away too little is to my mind much the graver fault" (*ibid.*).

is not the prominent feature, where the fixity is too great to be overcome by the removal of one bone, or where this step has been used and failed. Personally, I prefer this operation in every case, whether congenital or paralytic, which is beyond the remedy of judiciously employed "wrenching." When I say in every case, I should like to make one reservation. I am referring to the bulk of cases which come before a hospital surgeon. Where these can afford time and expense, where the parents have the good sense to be patient over the time which is required to secure good results—in such cases milder methods often will suffice. But with the great majority of hospital cases it is not so. Time for schooling, apprenticing, and so forth, is urgently needed, perhaps much has been already lost. Even moderately expensive apparatus is difficult of attainment, intelligence and patience on the part of the parents or patient is, very often, not forthcoming, the regular attendance which is absolutely needful is broken off or interrupted, and the inevitable relapses are well known to every surgeon of experience. Looking upon treatment here as mainly a question of time, not only to fit the patient to play his part in life's battle, but because the longer the deformity is left, the worse is the habit of walking acquired, I generally resort to tarsectomy in patients as young as ten or eleven, and very occasionally even younger. I admit the foot is flat and shortened, and, in some cases, stiff, though this last is due to imperfect after-treatment and insufficient manipulation and active and passive exercise of the foot. *Though flat and shortened, the foot is square, without any tendency to inversion after a well-managed tarsectomy.* This, I maintain, is the chief object before us in these resistant cases of talipes, and, as it is attained most speedily and certainly by tarsectomy, I recommend this operation strongly in poorer patients who can least afford to lose time.

With regard to the matter of **age**, I would refer my readers to papers by Mr. Walsham (*Brit. Med. Journ.*, 1893, vol. i. p. 339), and Mr. Ewens, Surgeon to the Bristol Children's Hospital (*ibid.*, 1891, vol. ii. p. 843). Both these surgeons advocate resort to removal of bone at an earlier age than is usually allowed. Both consider such operative steps justifiable, in special cases, in children only three years old. In Mr. Walsham's words: "I have not done a bone operation on these patients at a younger age than two or three years, but at that tender age I have found that, even after removal of the astragalus, the foot in some instances could not be got into a satisfactory position until further portions of the bones had been excised." Where, with the advantages of a well-ordered special department, skilled assistants and nurses, and ample experience, Mr. Walsham finds milder methods fail, other surgeons working, perhaps under less happy surroundings, need not fear to resort, in like occasional cases, to removal of bone.

Operation.—The parts, having been rendered evascular with Esmarch's bandages, are duly cleansed and supported on a sand-bag. A T-shaped incision is then made with the horizontal limb along the outer side of the foot over the os calcis and the cuboid, and the longitudinal one at a right angle to this passing across the dorsum and ending over the scaphoid. The flaps thus marked out are turned aside. With a periosteal elevator the tendons and vessels in the dorsum are now raised so that sufficient room is given for the saw to pass between them and the bones. With a retractor on the outer side the peronæi tendons are held out of the way, due care being taken of their sheaths to avoid the risk of sloughing. With a narrow-bladed saw, a wedge of bone of sufficient size is then removed by two cuts, one above and one below, meeting at the scaphoid. The upper of these will pass through the os calcis to the scaphoid, the lower through the cuboid, through the joint between this and the fifth metatarsal, or through the base of this bone, according to the severity of the case. While these sections are made, a blunt dissector may be pushed under the bones very close to their plantar surfaces, so as to protect the soft parts beneath. The wedge of bone is then

removed with a lion-forceps, or by levering it out with an elevator, care being taken not to damage any parts used as a fulcrum. As it is twisted out, a few attachments to the structures in the sole may require division or peeling off. If the position of the foot cannot be rectified, the gap must be widened by removing more bone either with a saw or with a chisel and mallet; it is especially towards the apex that this must be done.* When the foot can be brought into good position any tendons that have been divided are united with carbolized silk or chromic gut. Any vessels which can be seen are then secured, a drainage-tube is inserted, and the wound partly closed with one or two sutures. Sufficient gauze dressings are then firmly bandaged on before the Esmarch's bandage is removed. The foot is put up with a back and two side splints, or on an external splint with an interruption, the knee being flexed and the limb resting on its outer side. Mr. Davy has devised a special splint to secure eversion. Morphia should be given freely at first if required. In six or eight weeks the union should be firm.

If after the operation the foot still turns in because the whole limb does so, osteotomy of the femur at about the junction of the middle and lower thirds should be performed, and the leg and lower fragment turned somewhat outwards.

Great care must be taken during the after-treatment to keep the parts aseptic. Mr. Davy lost one case, two weeks after the operation, from septicæmia (*Brit. Med. Journ.*, 1879, vol. i. p. 221). Cellulitis, œdema, &c., are of very likely occurrence, if, owing to an insufficient wedge being removed, much force has to be employed to correct the inversion. Occasionally complete closure of the wound is delayed by the coming away of a scale of bone; the ill-vitalized corns and bursal tissues may show some signs of sloughing.†

CHOPART'S AMPUTATION (Figs. 383-386).

In this medio-tarsal amputation only the astragalus and the os calcis are retained, disarticulation being effected through the joints between the above bones and the scaphoid and the cuboid.

Value of the Operation.—This has been a good deal disputed. The following objections have been raised to it:

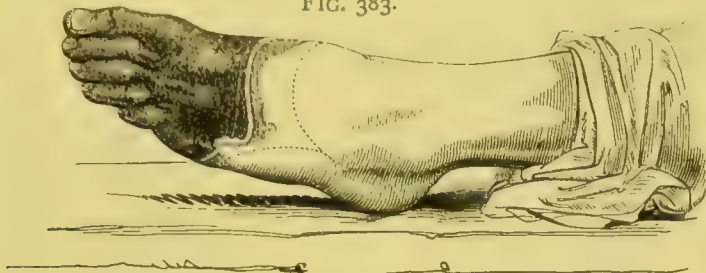
1. That the tendo-Achillis, no longer counterbalanced by the extensor muscles which have now lost their attachment, draws up the heel, tilting down the scar, which now becomes tender and irritable (Fig. 386). 2. In the normal foot the weight of the body is transmitted through the astragalus to the other bones of the tarsus and metatarsus. When, as in this amputation, these bones have been removed, the weight of the body tends to thrust forward the astragalus, no longer supported by the elastic bones in front, against the scar (Fig. 386), and thus renders this tender and crippling. The above objections apply

* Some contracted tendons may now require division before the inversion can be completely overcome. The tendo-Achillis may be divided now, or later.

† In a case of Mr. Bennett's (*Clin. Soc. Trans.*, vol. xv. p. 83) erysipelas attacked the sinus, which was all that remained of the wound, and all the union between the bones, which had come firm, gave way. The case ultimately did well.

to the operation performed for injury or disease, the next to amputation for the latter only. 3. If the operation be made use of in caries, this disease is likely to recur in the two bones left. In answer to the first two of the above objections it may be said that this tendency to tilting upwards of the heel and downwards of the scar may be met: (*a*) By stitching the anterior tendons—*e.g.*, tibialis anticus, extensor proprius pollicis, and some of the tendons of the extensor communis—into the tissues of the sole-flap with

FIG. 383.



Incisions in Chopart's amputation. (Fergusson.)

stout carbolised silk or chromic gut, so as to give them a fixed point by which they may counterbalance the tendo-Achillis;* (*b*) by cutting the plantar flap sufficiently long, and securing firm primary union; (*c*) by division of the tendo-Achillis. This, however, is only of fugitive value; (*d*) wearing a wedge-shaped pad in the boot; (*e*) preserving the scaphoid when sound so as to retain the attachment of the tibialis posticus. "It has not been shown that this modification is of special value" (Treves).

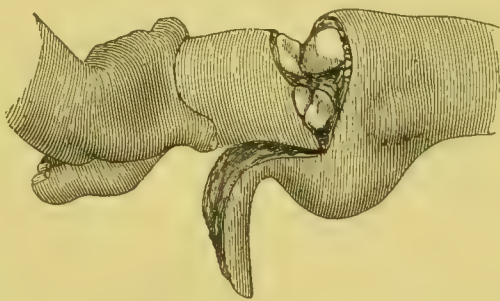
The third objection is answered by only performing this operation for caries, when the disease is limited to the front of the foot, when it is of distinctly traumatic origin, and occurs in a healthy patient.

Operation (Figs. 383, 384).

—An Esmarch's bandage being applied, and the foot supported at a right angle over the edge of the table, the surgeon, standing to the right side of the foot, and so that he can easily face the sole, places (*e.g.*, on the right side) his

left index and thumb immediately above the tubercle of the scaphoid and the corresponding point on the outer side—*viz.*, the

FIG. 384.



* We owe this ingenious precaution to Mr. Delegarde, of Exeter. Till it is more frequently made use of, and a larger number of cases are collected, the value of this amputation must remain somewhat undecided. I have operated on five occasions, one a severe crush, another for the results of perforating ulcer, and in three for caries of the front of the foot—in all this precaution was taken, the stumps proved sound and useful. One I have watched for four years.

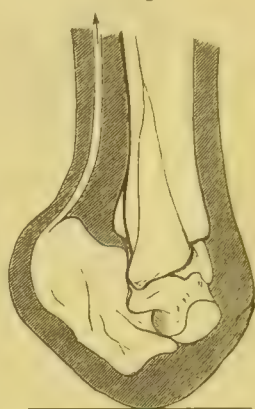
calcaneo-cuboid joint, which lies midway between the external malleolus and the base of the fifth metatarsal bone. He then joins these points by a slightly curved incision crossing the tarsus, and dividing everything down to the bones. The foot being flexed upwards, a plantar flap is then marked out by an incision running from the outer extremity of the first up the outer side of the little toe, then across the sole, and then down the inner side of the great toe to join the inner extremity of the first.* The flap thus marked

FIG. 385.



Stump after Chopart's amputation.
(Fergusson.)

FIG. 386.



Stump often met with after Chopart's amputation, showing its shape, the position of the bones, and the influence of the tendo-Achillis. (Farabeuf.)

out is raised with the same precautions given at p. 1263. It is then held out of the way, and the anterior half of the foot being strongly depressed, disarticulation is effected by passing the knife above the tubercle of the scaphoid between this bone and the astragalus, and then between the concavo-convex surfaces of the calcaneo-cuboid joint. In effecting this the position of the joints and the shape of the astragalus must be remembered, and Mr. Skey's words borne in mind: "The joints should be opened with tact and not by force: if the knife be applied to the right surface, it will pass without effort into the articulation; if in the wrong direction, no force will effect it."

The anterior tibial and plantar arteries are then secured, and, on removal of the Esmarch's bandage, any other vessels which require it. The flap is then folded up over the bones, but without any forcible bending, which might interfere with the blood-supply. While it is held in this position, before any sutures are inserted, the extensor tendons (*vide supra*) should be carefully stitched with sufficiently stout silk, into the fibrous tissues which abound in the heel-flap, care being taken, in so doing, not to puncture the

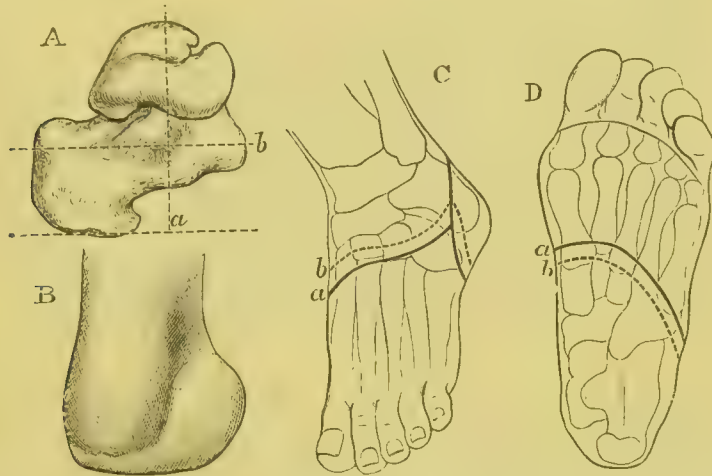
* The flap should be a full inch shorter than that in Lisfranc's operation (p. 1263), if the tissues are sound. An unduly long and large plantar flap will here, as after a Lisfranc's amputation, form an unwieldy pocket (Treves).

external plantar vessels, but at the same time to secure a sufficient hold. The sutures inserted to hold the plantar flap *in situ* must be sufficient in number and stoutness, and must be retained till the flap is soundly incised.

TRIPIER'S AMPUTATION* (Fig. 387).

This operation was proposed by Dr. L. Tripier, of Lyons, as an improved modification of Chopart's amputation, over which it is thought to possess the following advantages: (1) The horizontal division of the os calcis on a level with the sustentaculum tali gives a large surface of support entirely free from the objections to that in Chopart's amputation (p. 1258). Mr. Wagstaffe (*Lond. Med. Record*, 1880, p. 135) points out further advantages—*e.g.*, that less plantar flap is needed, and that the operator can see the state of the os calcis, amputating higher if this bone be too much diseased. The advantages of M. Tripier's

FIG. 387.



Tripier's amputation. *a.* Section through the skin. *b.* Through the soft parts. (Bryant.)

amputation over the sub-astragaloid (p. 1242) are: (i) The limb is longer, (ii) the section of the os calcis gives a larger and more solid basis of support. (2) By making the section of the os calcis, the tendons, especially the tendo-Achillis, are better preserved. Plantar and dorsal flaps are marked out by the following elliptical lines, the dorsal starting from the outer part of the tendo-Achillis at its insertion, then passing about $1\frac{1}{4}$ inch below the external malleolus forwards to a point about the same distance above the tuberosity of the fifth metatarsal bone; the incision then curves inwards to end at the inner side of the extensor proprius hallucis, over the tarsal end of the first metatarsal bone. From this point the plantar flap is marked out by an incision downward and forward over the inner part of the sole, about an inch in front of the base of the first metatarsal bone, and then obliquely across the bases of the metatarsals, and, lastly, backwards, so as to join the dorsal incision over the outer part of the os calcis. All the dorsal tendons are then divided along the line of the incision, and the structures in the plantar incision are next cut down to the bones, and a thick

* A case of this amputation by Mr. Hayes, of Dublin, will be found in the *Brit. Med. Journ.*, 1881, vol. i. p. 303.

plantar flap is then raised until the under surface of the os calcis is exposed, and the point of the heel turned. Disarticulation, as for Chopart's amputation, is then performed. The periosteum covering the under aspect of the os calcis is now incised antero-posteriorly, and detached from the bone up to the level of the sustentaculum tali. The os calcis is next sawn through horizontally from within outwards, on a level with the same process. The projecting angles are then rounded off, and the plantar and dorsalis pedis arteries tied. As in all amputations, the nerve that will be in the flap that will bear pressure—here the posterior tibial—should be trimmed short.

AMPUTATION THROUGH THE TARSO-METATARSAL JOINTS (Figs. 388–390).

This, though usually spoken of as Hey's or Lisfranc's amputation, includes, accurately speaking, the following **operations**:
 1. **Lisfranc's**.—Amputation by disarticulation through all the joints. 2. **Hey's**.—This is usually described as amputation here by sawing through the bases of the metatarsals. In reality, Hey seems to have disarticulated through the outer four joints, and sawn off the projecting internal cuneiform (*Observations in Surgery*, 3rd edition, p. 552). 3. **Skey's**.—Disarticulation through the outer three and the first joints, the second metatarsal being sawn through (*Oper. Surg.*, p. 406).

Indications.—Few. (1) Limited crushes in which the sole is sound. (2) Disease limited to the front of the foot. (3) Inveterate bunion, with persistent sinuses and recurrent attacks of cellulitis. (4) Perhaps perforating ulcer. (5) Some cases of frost-bite.

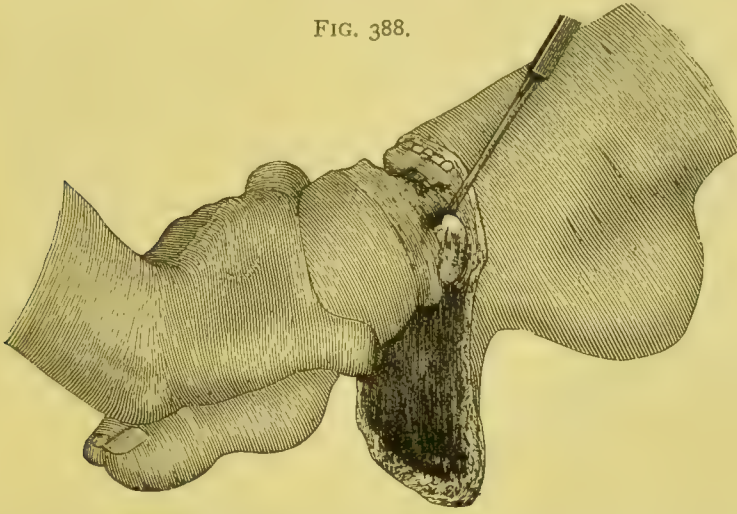
Owing to the complexity of the synovial membrane here, any disease which has invaded the synovial membrane between the second and third metatarsals and the second and third cuneiforms, has also spread to that between the scaphoid and three cuneiforms. This, though of small moment in cases of injury, should put this amputation aside in most cases of disease.

Lisfranc's Amputation (Fig. 388).—The preliminaries are the same as in Chopart's amputation. The surgeon, standing to the right side of either foot, and so as easily to face the sole, places his left index and thumb on the bases of the little and great toe metatarsals respectively. The first of these can always be found by pressure, even if swelling is present; if there be any difficulty with the latter, it will be found a full inch in front of the readily detected tubercle of the scaphoid. These two points thus marked out are joined by a slightly curved incision with its convexity forwards. As a rule, if the tissues in the sole are sound, no dorsal flap should be made, the above incision being kept close to the line of the joints through which disarticulation is to be performed.

The foot being now flexed upwards, the surgeon, looking towards the sole, marks out a plantar flap by an incision running from the outer extremity of the first cut (for the right foot) up the outer

side of the foot, then across the heads of the metatarsals, and down the inner side, so as to join the inner extremity of the dorsal incision. This flap should be made a little longer on the inner than on the outer side of the foot, so as to cover the additionally projecting bones on this side. Its cut edge being taken firmly between the finger and thumb, the flap is then dissected up as thickly as possible—*i.e.*, containing all the tissues possible in the sole. In keeping the knife close to the bones some of the metatarso-phalangeal joints will probably be opened. Below these the flap, if steadily pulled upon, will, with light touches of the knife, readily separate from the metatarsal bones. The flap should be raised evenly, and without scoring or any button-holes. The

FIG. 388.



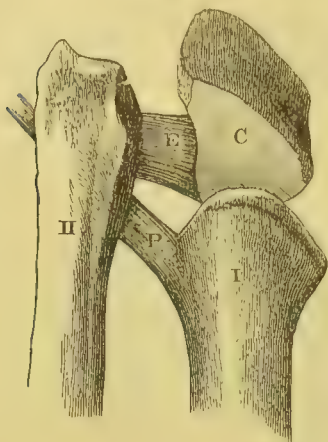
Disarticulation of the second metatarsal in Lisfranc's amputation. The knife is being used as described below to separate the second from the first metatarsal bone.

prominent bases of the first and fifth metatarsals being laid bare, a few strong touches of the point of the knife may be required to separate part of the tibialis anticus and peronæus longus from the base of the former. The anterior part of the foot is now strongly depressed so as to stretch the dorsal ligaments, and the knife, having been thoroughly carried round the base of the fifth metatarsal, is drawn obliquely forwards and inwards so as to open the joints of the outer three metatarsals with the cuboid and the external cuneiform. The joint between the first metatarsal and the internal cuneiform is next opened, and, lastly, the second metatarsal is next freed as follows: The knife being held firmly in the fist, its point is inserted between the first two metatarsal bones, and the knife carried backwards and forwards in an antero-posterior direction in the long axis of the foot (Fig. 388). The same is then done between the second and third metatarsals, and, the lateral ligaments being thus divided, the joint between the second metatarsal and the middle cuneiform is then found and

opened,* this being facilitated by strongly depressing the foot, care being taken not to do this so violently as to separate the second metatarsal from its upper epiphysis, or to fracture the bone.† A few remaining touches of the knife, aided by a twisting movement, will then suffice to separate the foot.

The method by disarticulation may be a useful test of a candidate's knowledge and skill at an examination. In practice sawing

FIG. 389.



C. Internal cuneiform. I. First metatarsal. II. Second metatarsal. E. Internal tarso-metatarsal interosseous ligament, passing between internal cuneiform and adjacent angle of second metatarsal. P. Peroneus longus. (Farabeuf.)

FIG. 390.



Stump after Lisfranc's amputation.
(Fergusson.)

through the metatarsals just below their bases may nearly always be substituted as giving equally good results with a great saving of time and trouble. The truth of this I have personally tested.

This method of cutting the plantar flap before any attempt is made to disarticulate is strongly recommended in preference to disarticulating immediately after making the dorsal incision by passing the knife behind the bones and cutting the flap from within outwards. In thus disarticulating before making the plantar flap, it is quite possible to puncture the tissues in the sole, and perhaps to wound the external plantar artery. Again, passing the knife behind the metatarsal bones often leads to a hitch, especially with the projecting fifth.

The dorsalis pedis and the external plantar artery are now secured with any smaller vessels which need it. Tendons are cut square, drainage provided, and the plantar flap then brought up and secured in accurate position.

* The position of this joint must be remembered and the way in which the base of the second metatarsal bone is locked in between its fellows and the cuneiform bones. Its base projects upwards between $\frac{1}{2}$ and $\frac{1}{4}$ inch above the others.

† While the surgeon is disarticulating the metatarsal bones the plantar flap must be held well out of the way to prevent its being punctured.

Owing to the thickness of the heel-flap and its tendency at first to unfold itself downwards, numerous points of suture, of sufficiently stout wire or carbolized silk, must be made use of, or one or two hare-lip pins may be employed.

AMPUTATION OF THE TOES.

Practical Points.—(1) Any plantar scar is to be avoided. (2) The line of the metatarso-phalangeal joints lies a full inch farther back than the inter-digital folds of the skin* (Holden). (3) Partial amputations (save in the case of the great toe) are very seldom advisable, the stumps left being of little use, and inconvenient owing to their liability to stick upwards.

AMPUTATION THROUGH THE PHALANGES OR THE INTER-PHALANGEAL JOINTS.

These operations are not recommended, for the reasons just given. If a patient insist on having one performed, the directions already given for the fingers (p. 5) will be found sufficient.

AMPUTATION OF ANY OF THE FOUR SMALLER TOES AT THE METATARSO-PHALANGEAL JOINTS.

This amputation is performed much as in the case of the fingers (p. 6), but the following points must be remembered:

(1) The line of the joint lies a full inch above the web (*vide supra*). (2) The head of the metatarsal bone is not here removed so as to leave the supporting power of the foot undiminished. (3) It is most important to avoid, as far as possible, any scar in the sole.

The scar, a simple antero-posterior one, is well protected by the adjacent toes. The incision should always be begun on the dorsum, even in the case of the little toe, so as to avoid friction of the boots.

AMPUTATION OF GREAT TOE AT THE INTER-PHALANGEAL JOINT (Fig. 355).

This is usually performed with a plantar flap, much as at p. 2.

AMPUTATION OF GREAT TOE AT THE METATARSO-PHALANGEAL JOINT (Figs. 391, 394).

This is performed by the oval method described at p. 6. The following points must be borne in mind:

(1) Owing to the large size of the head of the metatarsal bone,

* According to Erichsen, it will be found, as a general rule, that these articulations are about the same distance above the web as the point of the toes are below it. This, I think, places the line of the joints too high.

the flaps are often cut of insufficient length. The incision must

FIG. 391.



Dorsal and internal flaps for amputation of the great toe and the head of its metatarsal. (Farabeuf.)

be begun $1\frac{1}{4}$ inch above the joint, and carried well on to the phalanx, one flap being cut longer than the other if needful. (2) The sesamoid bones must be left in connection with the head of the metatarsal bone, as any attempt to dissect them out is likely to imperil the vascularity of the flaps, especially after middle life.

In all other details the steps of this amputation are very similar to those already given at p. 6.

Though it is recommended by some excellent surgeons to remove

FIG. 392.



FIG. 393.



Amputation of the little toe by a single dorsal and external flap. (Farabeuf.)

the head of the metatarsal bone either transversely or obliquely from within outwards, this step, narrowing as it does the treading width of the foot, is not advisable, unless the condition of the skin is such as to render it impossible to obtain sufficient flaps to cover the entire head.

FIG. 394.

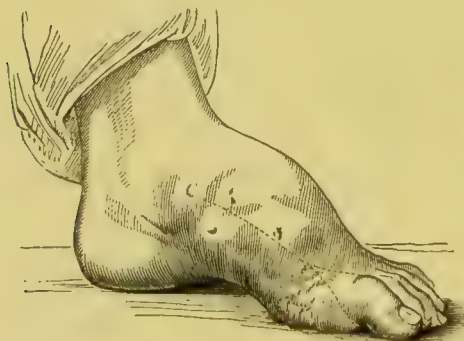


FIG. 395.



Amputation of great toe and its metatarsal bone by internal flaps. (Fergusson.)

The foot left by the operation. (Fergusson.)

CHAPTER VIII.

OSTEOTOMY.

OSTEOTOMY OF THE FEMUR FOR ANKYLOSIS OF HIP-JOINT—FOR GENU VALGUM.—OSTEOTOMY OF THE TIBIA.—OSTEOTOMY FOR DISPLACEMENT OF THE GREAT TOE IN BUNION.

FOR ANKYLOSIS OF HIP-JOINT.

THIS includes Adams' operation of division of the neck of the femur and Gant's operation of division of the shaft of the femur just below the trochanters. The latter being much the simpler, and giving excellent results, will, I think, replace the former.

Indications.—Cases in which the hip-joint is permanently flexed and stiff, and the patient accordingly crippled, either from old hip disease, or from ankylosis after rheumatic fever, pyæmia, &c.; cases in which extension has failed, together with trials of straightening the limb with the aid of anæsthetics.

Adams' operation divides the neck of the femur subcutaneously within the capsule. It is best suited for those cases in which the neck remains unabsorbed, as in ankylosis after rheumatic fever, and, much more rarely, pyæmia. A long tenotome or a straight narrow bistoury is entered a little above the great trochanter, and carried straight down to the neck of the femur, dividing the muscles and opening the capsule freely. The knife being withdrawn, the excellent saw which bears Mr. Adams' name is passed along the wound made down to the neck of the bone, which is then sawn through. After sawing for about four or five minutes, the limb should become movable. If this is not the case, the section has been made, not through the neck itself, but through the junction of the neck and shaft.

In order to bring down the limb completely, the contracted tendons of the adductor longus, sartorius, and perhaps the rectus, will probably require division with a tenotome. The operation should be conducted with strict antiseptic precautions.

The limb is straightened at once, and put up with a long outside splint—*e.g.*, a Désault's—and a little morphia given if needful. There is no hæmorrhage, and the wound heals quickly.

This operation gives good results, though, as stated below, I prefer Gant's, owing to its greater simplicity. For there is no doubt that if the bone is dense from previous inflammation, and if the section trenches upon the shaft instead of going through the neck only, the sawing may be very tedious. Thus, I have seen two cases in which this took over half an hour.

A case is mentioned in a report from a committee of the Belgian Academy of Medicine, in which a patient who had been submitted to Adams' operation insisted on getting up on the twentieth day. Hemorrhage came on from the fragments wounding the femoral vessels or some large branch. The femoral was tied just below Poupart's ligament; the hemorrhage ceased, but free incisions were required for suppuration. The patient ultimately recovered. The same committee reported a death from hemorrhage, and one from purulent infiltration. No bad results have, I believe, followed in England.

Gant's Operation.—Here the shaft of the femur is divided just below the trochanters.

Advantages.—The operation is a simpler one than that just given, as the shaft is more readily reached and divided than the neck. Furthermore, it is an operation of wider applicability, for it is suited to all cases, not only those in which a neck remains, but those more common cases of ankylosis after hip-disease, in which repair has taken place with partial displacement of the head, or what remains of it. The fact that in these cases there is next to no neck left to divide, makes them unsuited for Mr. Adams' operation.

A long tenotome or, better, a sharp-pointed, narrow, straight bistoury is entered just below the great trochanter, and made to divide everything down to the bone as it is lodged upon the outer aspect of the anterior surface, and then drawn down over the outer surface of the shaft. As it is withdrawn, the wound is a little enlarged downwards. The saw is then introduced along the wound well down to the bone, and the outer two thirds of this sawn through, the rest being effected by snapping the bone by lateral movements. The same tendons (p. 1267) will probably require division.

In neither case is it any practical good to try and secure a false joint.

OSTEOTOMY FOR GENU VALGUM (Figs. 396–398).

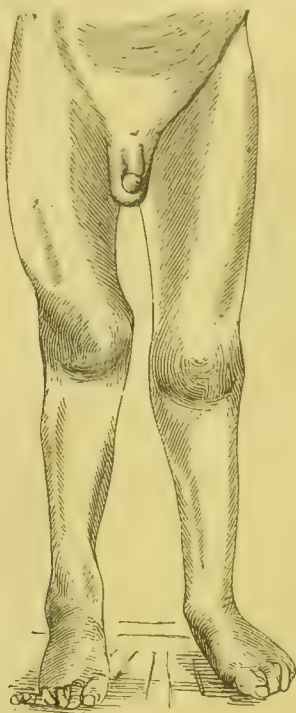
Under this heading the following operations will be described:—

- I. Division of the Shaft of the Femur from the Outer Side (Fig. 398).
- II. Division of the Lower End of the Femur from the Inner Side, just above the Epiphysial Line (Mac-ewen Fig. 398).
- III. Division of the Internal Condyle Obliquely (Ogston).
- IV. Division of the Lower End of the Femur and the Upper End of the Tibia above and below their respective Epiphyses (Barwell).

I. Division of the Shaft of the Femur from the Outer Side (Figs. 396–398).—The limb being supported, with the knee flexed, on a sand-bag, an incision about $1\frac{1}{2}$ inches long is made at a right angle to and down to the bone on its outer side, about 3 inches above the external condyle. The knife—a narrow, straight bistoury—should go down to the bone deliberately, and cut firmly

and strongly on it, enlarging the wound slightly as it emerges, in order that the soft parts may not be damaged if the heel of the saw is depressed, and that there may be no lip of tissues to hinder the escape of discharges. The saw or chisel is then introduced, and the bone divided for its outer two-thirds. As the thicker part

FIG. 396.*

FIG. 397.¹

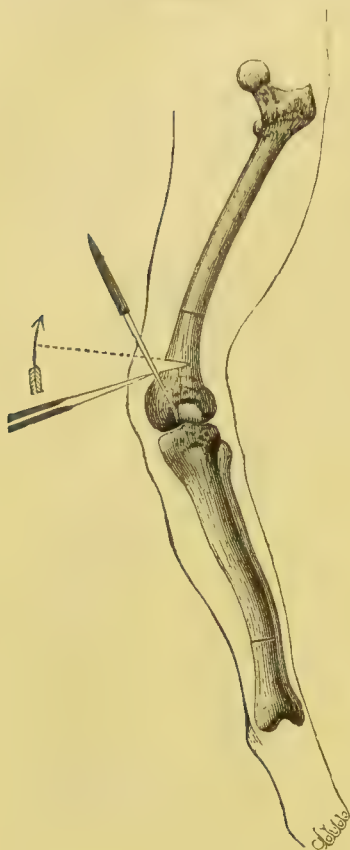
of the bone is on the outer side, as soon as this is divided the inner third usually gives way readily on carrying the knee and leg from without inwards. But the operator should continue the division of the bone till he can feel certain that two-thirds are divided, for if, after dividing only half, he tries, especially in the case of a dense bone, to fracture the rest and straighten the limb, either great or prolonged force must be made use of, leading probably to irritation, cellulitis, and suppuration, with, perhaps, necrosis; or the saw or chisel must be re-introduced, a point to be always avoided if possible, as the difficulty which is usually met with in hitting off the original track will be likely to lead to the above drawbacks.

The *advantages* of the above method are (1) that the femur is divided at a much narrower part than in the supra-condyloid operation of Macewen, and that thus it is more easily and quickly

* Double genu valgum treated by division of the shaft of the femur from the outside. A good average case, both as to its severity and the results of operation. Some flat foot remains on the left side.

done. (2) The bone section is farther away from the epiphysis, and the line of the synovial membrane, in case subsequent inflammation takes place. (3) There are no important blood-vessels near (p. 1274).

FIG. 398.



The transverse line on the shaft of the femur shows the site of division of the bone from the outer side. Below this are shown Macewen's and Ogston's operations. The arrow indicates the direction in which the osteotome is worked in the former. The line on the tibia shows the sight of division of the bone for an ordinary rickety curve. This curve in the lower third should have been shown more marked. (After Barker.)

II. Division of the Lower End of the Femur from the Inner Side, just above the Epiphysial line (supra-condyloid of Macewen*) (Fig. 398).—The knee being flexed and supported firmly on a sand-bag, the skin cleansed, the position of the adductor tubercle is defined, and a longitudinal incision about an inch long (a little longer than the breadth of the chisel to be used) is made down to the bone at a point where the two following lines meet—viz., one drawn transversely a finger's-breadth above the superior tip of the external condyle, and another drawn longitudinally about $\frac{1}{2}$ inch anterior to the adductor tubercle. The scalpel goes at once down to the bone. Superficial veins may be cut, but no artery normally distributed, as the incision is below and anterior to the anastomotica magna and above the superior internal articular. Before withdrawing the knife, the osteotome † is introduced by its side down to the bone in the same way as the knife—i.e., parallel to the long axis of the limb—is then turned at a right angle to it, and the inner two-thirds cut through. *The direction of the bone-incision* is most important. The surgeon must cut transversely across the femur on a level with a line drawn $\frac{1}{2}$ inch above the tip of the external condyle.‡ Otherwise, as in a

* Osteotomy, p. 120.

† In adults a second, or even a third, finer instrument may be used, being slipped in over

the first as this is withdrawn. In children one instrument will suffice.

‡ The incision above given will avoid the epiphysis and synovial membrane. The line of the former may be usually represented by one crossing the femur at the level of the highest point of the femoral articulating surface, and running through or just below the adductor tubercle, so that, the incision being an inch above the tubercle, the epiphysis will be cleared. The only part of the synovial membrane which is as high as the bone incision is that under the quadriceps, which may reach in the adult as high as 2 inches above the trochlear surface. It is somewhat triangular in shape, its base being at the condyles, and it generally

valgous limb the whole internal condyle is lowered, a line drawn transversely from the adductor tubercle might land the operator low down in the external condyle. The osteotome must be driven at first from behind forwards and to the outer side; it is then made to move forwards along the inner border until it comes to the anterior surface, when it is directed from before backwards and towards the outer posterior angle of the femur. By keeping on these lines there is no fear of injuring the artery. The hard exterior of the bone usually resists the osteotome, especially in adults, but several strokes cause it to penetrate this superficial dense portion,* when the instrument will pass easily through the cancellous bone. The surgeon will soon recognise by touch or by hearing when the osteotome meets the hard layer on the opposite side. If it be thought desirable to penetrate this outer dense part, it must be done very steadily, so as to check any undue impetus on the part of the osteotome. A sponge, wrung out of 1 in 40 carbolic lotion, is then placed over the wound; the surgeon, grasping this and the limb with his left hand, and taking the limb again lower down with his right, gives the extended limb thus held a quick jerk inwards; this is repeated if needful, or the limb may be carried outwards, and thus broken or bent sufficiently.

III. Division of the Internal Condyle Obliquely (Ogston†) (Fig. 398).—This operation, though a great improvement on the operations which preceded it—viz., opening the joint and sawing off the internal condyle—has been entirely replaced by others—viz., Macewen's, and division of the shaft from the outer side. The free opening of the joint, with its great risks if the wound becomes septic, and the stiffness in any case, have led to this.

The limb, being flexed and supported on a sand-bag, a long tenotome is entered about an inch above the upper border of the articular surface of the femur exactly in the middle of the inner aspect of the thigh, and with it an incision is made down to the bone, downwards and forwards, until its point is felt beneath the skin in the inter-condyloid notch.‡ The knife must cut down upon the bone decidedly, and, as it is withdrawn, it must enlarge the opening for the saw. An Adams' saw is then thrust along the knife track, and the inner condyle sawn off from before backwards. The bone must be sawn almost completely through, the strokes being increasingly careful as the back of the bone is reached. When the section is thought to have nearly reached this point the saw is withdrawn, the wound covered with a carbolised sponge, and the extended leg

tapers to the middle line as it ascends. There is generally a quantity of fat between it and the bone. The spot selected by Dr. Macewen for his incision is posterior to this point.

* The osteotomes must be bevelled on both sides, wedge-like, and sufficiently trustworthy for hardness and toughness, points only to be secured by getting them of first-rate and painstaking makers. Dr. Macewen's test is as follows: If the instrument will neither turn nor chip in penetrating the thigh-bone of an ox, it is well suited for cutting human bones.

† *Edin. Med. Journ.*, March 1877.

‡ If the patella is sufficiently dislocated outwards, the point of the saw can be felt in the groove; but if the patella is not so displaced, it must be lifted up and the point of the saw passed under it.

forced strongly inwards. The condyle now slips up somewhat on the cut surface of the femur.

IV. Division of Tibia as well as Femur.—The division of the tibia (and the fibula also) as well as the femur has been advocated by Mr. Barwell. In the majority of cases, though, at first sight, there may seem to be one striking curve localised to one spot, a closer examination shows that in reality several curves are present, and often of different kinds, antero-posterior as well as lateral, diffused over the whole shaft rather than limited to one end. In these cases, rectifying one curve often makes the others more prominent. Multiple osteotomies are required here, the femur and the tibia each requiring division in two places. In one very aggravated case of genu varum, in which the limbs (when the ankles were placed together) formed a circle, Prof. Macewen performed ten osteotomies at one time (*loc. supra cit.*, figs. 40 and 41). In such severer cases most operators will prefer to straighten one side at a time.

Operation.—An incision is made as at p. 1273 over the inner surface of the tibia just below its tubercle, and the bone divided with an osteotome or saw from within outwards. The tissue on the anterior part just below the tubercle is much the densest. The section of the tibia should be made on the same occasion as that of the femur.

However an osteotomy wound is made, whether with saw or chisel, no attempt should be made to close it, but a little iodoform dusted on and gauze dressings applied. It is very rarely needful to remove these before the tenth or fourteenth day. If a stain come through, it should be dusted with iodoform and a little fresh dry dressing applied.

Prof. Macewen uses a splint consisting of a long outside, and a short back, with a foot-piece.* I have usually preferred plaster-of-Paris, applied by Mr. Croft's method, for children, amongst whom my experience has mainly laid. It makes even, steady pressure upon the muscles around the wound, keeping them and it at rest, and it allows the patient to be more easily moved, especially when both limbs have been operated on. The outer piece of flannel should be brought high up, to the level of the iliac crest, so as to better command the muscles which disturb the upper fragment. Where the child is likely to be restless a long outside splint should, also, be applied. I make use of this in all my cases of osteotomy of the femur. However the limb is put up, the bandages must be applied firmly and evenly, but without undue tightness. The condition of the toes, as to colour and movement, must be carefully watched. When the dressings are

* Prof. Macewen advises the use of a mattress consisting of four parts, the two centre pieces corresponding to the gluteal region, and easily removed to admit of the introduction of the bed-pan.

removed at the end of ten or fourteen days I like to have an anæsthetic given, and to rectify any slight remaining deformity.

The splints or plaster-of-Paris should be continued for six weeks, when the limb may be only supported with sand-bags if the union is firm. Passive and active movement may be now allowed. In about three months the patient may be got up, with a stick, under observation. Before the patient leaves the surgeon's eye, care should be taken that he can bend his knee well.

OSTEOTOMY OF THE TIBIA.

This may be (A) **Simple Division** or (B) **Cuneiform**—*i.e.*, the taking out of a wedge of bone. The former of these, a very simple operation, will suffice for the ordinarily curved tibiæ, where the bone is bent laterally, and the bend is most marked at the junction of the middle and lower thirds. Cuneiform osteotomy will be required when the bending is not only lateral, but antero-posterior as well.

A. Simple Osteotomy of the Tibia (Fig. 398).—The parts being cleansed and the limb resting on its outer side on a firm sand-bag, the surgeon notes, at the anterior and inner margins of the tibia, the spot where the curve is sharpest. Fixing his left index over the inner margin, he enters a long tenotome or narrow bistoury exactly over the crest of the tibia, sends it down under the skin over the inner surface of the bone till its point is felt just beneath the finger; it is here pushed through the skin to make a counter-puncture for drainage. The knife, hitherto held horizontally, is now turned vertically and cuts firmly on the bone, dividing the periosteum, thick in these cases, in one line right across the inner surface of the tibia. As the knife is withdrawn it is made to enlarge the wound of entrance slightly, to make room for the saw. This (Adams') is now introduced in the same way as the knife, carried horizontally down to, but not through, the puncture through the skin of the inner border of the tibia. The left index keeping guard over the tibial artery, the saw is turned towards the bone and cuts through the inner two-thirds of it. The entrance of the saw into cancellous tissue can be known by the diminution of resistance and the increased bleeding which often occur, but the best test of the depth to which the operator has arrived is the depth of the groove in which the saw has sunk. When the bone is sawn sufficiently, carbolised lint is placed on the wound, and the surgeon, firmly placing his two hands, close together, immediately above and below the wound, sharply carries the lower fragment outwards. If the saw has been sufficiently used, the tibia snaps distinctly, while the fibula yields with a "greenstick" sensation. Great care must be taken to exert the force just on the sawn portion, or the ligaments of the ankle or the superior tibio-fibular joint may be strained and damaged. Attention has already been drawn to the need of using the

saw sufficiently, otherwise the parts will be bruised and damaged in the futile attempts at fracture.

B. Cuneiform Division of the Tibia—Removal of a Wedge.—The parts being duly cleansed, an incision is made along the crest of the tibia equal to the base of the wedge which is going to be removed. It need not be longer, as the skin can be pulled up and down if needful. The periosteum is then divided cleanly, and separated from the tibia with curved scissors, sterilised. This membrane being held out of the way with retractors, a wedge is next removed with an osteotome or a narrow and sharp chisel but little bevelled. The gap can then be enlarged by removing from either side further shavings as required. Occasionally free hæmorrhage takes place from the medullary artery, but this soon stops with firm sponge pressure. The limb is now straightened by bending the lower fragment upwards* so as to bring the surfaces of the gap in contact. The periosteum at the upper and lower angles of the wound may be closed with chromic catgut sutures cut short. The skin wound is also closed above and below, but left open in the centre for drainage. In this and the preceding operation sufficiently thick dressings should be applied to meet any oozing from the bone. Plaster of Paris (p. 1272) or a back and side splints should be applied.

Cuneiform Division of the Femur.—In cases where the curve is chiefly an antero-posterior one affecting the middle of the shaft, the deformity can only be properly removed by taking out a wedge. This is done on the lines given above. An incision is made through skin and quadriceps down to the periosteum, and a second firm cut exposes the bone. The divided muscle is then drawn aside with Spencer Wells' forceps applied to bleeding points, and the periosteum separated on each side down to the *linea aspera*. A wedge is then removed and the bone straightened. The bleeding is often free from the nutrient artery, but this is arrested when the bone is straightened. The greatest care must be taken to keep within the periosteum, the soft parts being thus uninjured, and to adopt strict aseptic precautions.

OSTEOTOMY FOR DISPLACEMENT OF GREAT TOE IN BUNION.

Mr. Barker, at the suggestion of a University College student, has recommended this mode of correcting the inward deformity when very troublesome in these cases. Antiseptic osteotomy of the first phalanx will be found simpler, and thus preferable to division of the shortened external lateral ligament, and any tendons, such as the extensor longus digitorum, which require it. In bringing the line of the great toe straight after osteotomy, care must be taken not to do this too rapidly, or the contracted skin on the outer side of the toe may give way.

* Aided by movements in the opposite direction, and from side to side if needed. The fibula is broken subcutaneously.

Causes of Death and Failure after Osteotomy.

1. Septic troubles.—Such a case will be found published in the *Clin. Soc. Trans.*, vol. xii. p. 27. It is too probable that other operators have not been so candid. 2. Carboluria.—A case of rapidly fatal carbolic intoxication after antiseptic osteotomy of the tibia will be found in the same *Transactions*, vol. xiv. p. 201. 3. Hæmorrhage.—At least one case has occurred of hæmorrhage from the femoral and one from the anastomotica after division of the femur. I have also heard of one in which the posterior tibial was injured in osteotomy of the tibia. 4. Necrosis.

This occurred in one of my cases of osteotomy of the femur, a lad of sixteen. It was noticed that he took the anæsthetic (ether) very badly, and when the effects of this had passed off he was extremely restless and excited for forty minutes. To this I attribute the mischief that followed. Suppuration with a very unhealthy state of the wound, œdema, and cellulitis ensued, leading to necrosis. Eventually the lad recovered, but required a cork sole of 2 inches. The presence of a pre-systolic murmur perhaps accounted for the effects of the anæsthetic. 5. Division of the tibialis anticus tendon.—This occurred in an osteotomy of the tibia performed by one of my dressers, who forgot how close the tendon lies to the outer side of the crest. The cut ends were joined by chromic catgut, and the action of the muscle was, afterwards, unimpaired.

CHAPTER IX.

TENOTOMY.

TENOTOMY OF THE TENDONS ABOUT THE FOOT.— SYNDESMOTOMY.—TENOTOMY OF HAMSTRING TENDONS.—TENOTOMY OF STERNO-MASTOID.

TENOTOMY OF TENDONS ABOUT THE FOOT.

Division of Tibial Tendons.

Tibialis Anticus.—This is usually * divided where it is crossing the ankle-joint from without inwards, a little above its insertion into the internal cuneiform. It has, here, the dorsalis pedis vessels on its outer side, but separated from it by the extensor proprius hallucis.

The surgeon usually stands on the opposite side of the leg to that of the tendon, either facing the trunk or with his back towards it, as is most convenient. The assistant stands opposite to him, grasping the foot with one hand and the leg with the other. The position of the tendon is made out by making it tense by abducting and extending the foot. The surgeon then notes the position of the anterior tibial vessels, defines exactly the width of the tendon, and places the tip of his index finger exactly on the side of the tendon farthest from him. He then inserts the tenotomy knife vertically close to the tendon on the side nearest to him; sinks it lightly till he feels sure it is on a level lower than that of the tendon; then sends it horizontally across till he feels its point just under his index finger, and, having turned its edge upwards, finally, by a series of light levering or sawing movements, cut through the tendon. The assistant relaxes the foot—*i.e.*, adducts and bends it upwards—when the knife is first introduced, but places it on the stretch at a signal from the surgeon. Finally, as soon as the completion of the creaking sound and the sudden snap denote the division of the tendon, the foot is again relaxed. A small pad of gauze being at once applied, the foot is put up in the everted position. For this purpose nothing is, to my mind, so simple and efficient as a well-padded splint of the proper width, with two notches at its lower end, the upper end being just below the knee in infants, and the lower projecting $2\frac{1}{2}$ inches below the foot. The splint is applied to the outer side, the leg being first rolled in a flannel bandage to prevent pressure-sores.

Tibialis Posticus.—It is usually recommended to divide this $1\frac{1}{2}$ or 2 inches above the internal malleolus.* The tendon is here separated from the posterior tibial vessels by the flexor longus digitorum.

* For tenotomy of this and the tibialis posticus I greatly prefer the site given under Syndesmotomy.

† The tendon is here rather farther from the artery, and the surgeon will be

The surgeon and his assistant, occupying positions as at p. 1276, the exact site of the tendon is defined, if possible, by abducting and bending down the foot. In fat infants it is often quite impossible to feel the tendon, and in these cases a spot midway between the anterior and internal borders of the leg will be the best guide, as denoting the inner margin of the tibia. The surgeon then introduces a sharp tenotome so as just to touch, if possible, the inner margin of the tibia, taking care to sink the blade sufficiently to open the sheath freely. This being done, a blunt tenotome is introduced through the same opening, and pushed under the tendon; the edge being then turned towards it, and the tibia used as a fulcrum, the tendon is severed, together with that of the flexor longus digitorum. The assistant first relaxes and then extends the tendon, as advised above (p. 1276).

If the artery be cut, as shown by the jetting hæmorrhage and the blanching of the foot, firm pressure must be applied, the foot being first bandaged. No eversion must be practised, but the foot put up in the faulty position for about a week.

Plantar Fascia.*—This may be divided just below its origin from the os calcis, or in advanced cases close to the transverse crease, which is here found in the sole. With regard to this fascia, the surgeon should not tie himself down to any fixed spot, but divide resisting bands wherever they are felt.

Syndesmotomy.—This term has been introduced by Mr. R. W. Parker (*Congenital Club-foot*, p. 62 *et passim*), who believes that in many cases—*e.g.*, severe ones, cases not treated in early life, and in some relapsed cases—the foot cannot be rectified even by multiple tenotomy. He attributes this, not to adhesions, but to the faulty shortness, and unyielding nature of the ligaments. Chief amongst these, in equino-varus, are the ligaments about the astragalo-scaphoid joint. “In these cases there is a capsule made up above and internally by a blending together of the superior astragalo-scaphoid ligament with fibres from the anterior ligament, and the anterior portion of the deltoid ligament below with fibres from the inferior calcaneo-scaphoid ligament. To these are united fibrous expansions of the tendons of the anterior and posterior tibial muscles; together they form an unyielding capsule of great strength, which is attached to the several bones, not in the usual manner, but in adaptation to their altered relative positions. This I would name the ‘astragalo-scaphoid capsule.’” Mr. Parker gives directions for dividing this structure which can be made to combine division of the tibial tendons in a manner which I consider far more satisfactory than that already given. Since reading his book I have adopted his method in eighteen cases with good results. I much prefer it to that usually followed.

The site chosen for this combined division of tendons and ligaments is a little below and anterior to the tip of the internal malleolus.† Other guides are the site of the astragalo-scaphoid joint,

above the commencement of its synovial sheath, in which it traverses the internal annular ligament.

* Division of the palmar fascia is fully described at p. 20.

† Mr. Parker (*loc. supra cit.*, p. 78) shows that Velpeau and Syme pointed out the possibility of dividing the tendon of the tibialis posticus here.

and in older cases the transverse crease which, running down on to the sole, denotes the inversion of the foot. Two tenotomes are required, one of ordinary pattern, and one curved, somewhat sickle-shaped, and with a cutting blade about $\frac{1}{2}$ inch in length.

The surgeon notes the position of the tibial arteries, and the lines along which the tibial tendons are curving towards the internal cuneiform. Having marked, at the spot above given, the position of these tendons, he enters a sharp-pointed tenotome, the parts being relaxed, just above the posterior tibial artery, and pushes it inwards on to the dorsum to a spot just short of the anterior tibial artery, the knife being entered just below the skin to make a path for the next instrument, which does the work. The curved tenotome is then inserted under the skin, and pushed on, flat-wise, till its tip can be felt over the tibialis anticus; it is then turned blade downwards, the tibialis anticus is felt to give way, and, as the knife cuts on the subjacent bones and cartilages, the ligaments are felt to yield to it, while, as it is withdrawn, its edge divides the tibialis posticus.

The internal saphena vein would seem to lie under this incision, but the hæmorrhage, never marked, is usually very slight. As I have stated, the results in the eighteen cases in which I have used this method have been excellent, though in two I was unable to satisfy myself that the tibialis posticus had given way; in one it was certainly notched, and yielded subsequently.

As here the incision is made from the skin down upon the tarsal bones, I have used irrigation with lotion of mercury perchloride or carbolic acid. The wound is a comparatively free one, but quite subcutaneous, starting from a mere puncture.

As I have stated, I prefer to put up a case of talipes varus after syndesmotomy, with the foot everted at once, on a notched splint like a Dupuytren's, but applied to the outer side. If the tendo-Achillis requires division, this is done in a few days, and the foot put up for about a week, in good position, by Mr. Croft's method of plaster-of-Paris. After this, in early life, the foot must be manipulated *daily* by the surgeon for a while, and several times daily by the friends, the surgeon seeing it at first every other day. If these manipulations are persevered with daily by the mother or nurse, and the case kept under the surgeon's eye, expensive boots and other apparatus will not be needed in children.

Tendo-Achillis.—This should be divided half an inch above its insertion in an infant, and an inch and a half in an adult.

The foot and leg being turned well over on to the outer side, and the tendon being relaxed by the assistant bending the foot downwards, the margins of the tendon are accurately defined. The knife is then introduced vertically close* to the inner side of the tendon till it reaches a sufficient depth to ensure being

* So as to avoid the posterior tibial artery.

beneath it;* it is then pushed horizontally across under the tendon till it is felt under the skin by the left index finger, which accurately marks out the outer limit of the tendon; the blade is then turned towards the tendon, which being put on the stretch by bending up the foot, is divided by a series of levering movements of the handle. (Creaking movements, followed by a sudden snap or thud, denote complete division, when the tendon is to be at once relaxed and the knife brought out horizontally.

The Peronæi.—The peronæus longus and brevis occasionally require division. They may be divided simultaneously by entering a tenotome between them and the bone about two inches above the external malleolus. Immediately above this process they are more under cover of the bone. If divided below it, their synovial sheath would be opened, a result requiring greater care in cleanliness.

TENOTOMY OF THE HAMSTRINGS.

The patient being rolled two-thirds on to his face, the surgeon stands on the same side as that on which lies the tendon to be divided, facing or turned from the trunk as is most convenient. An assistant stands opposite to him to relax and tighten the tendon.

Biceps.—The exact limits of the tendon being defined, the surgeon introduces a sharp knife close to the inner side of the biceps, so as to get between it and the external popliteal nerve, and, having sunk it sufficiently to get beneath the tendon, pushes the knife outwards, horizontally, till it is felt beneath the skin under the left index, which marks the outer limit of the tendon. The edge being turned towards this, the tendon is extended by the assistant, and divided in the usual way. When this is done, the limb is flexed and the knife withdrawn horizontally.

When the tendon is cut, a cord often rises up close to it. This is the nerve, and the knife must on no account be re-introduced.

If, after tenotomy in long-standing cases, any contracted bands of fascia do not give way to extension, which they will generally do, it is wiser to make a small open wound, antiseptically, and divide them thus, that the surgeon may be certain as to what he is dividing. The wound is united afterwards with one or two horsehair sutures.

Semi-tendinosus and Semi-membranosus.—These tendons can be divided in the same way as the biceps. A contracted knee can generally be straightened after division of the biceps and semi-tendinosus. If it is needful to insert the knife more deeply

* Young operators often do not insert the knife sufficiently deep; they thus, when it is pushed across, get into the tendon instead of beneath it, and so divide it incompletely.

so as to divide the semi-membranosus, it would be well to use a blunt-pointed tenotome.

In one case of a girl of sixteen, after I had divided the biceps and semi-tendinosus, I had dipped the point of the knife a little more to ensure division of the deeper and larger semi-membranosus. Most profuse hæmorrhage followed from the superior internal articular vessels. Firm padding and bandaging were applied, and the limb put up in the faulty position for four days. No recurrence of the bleeding took place.

TENOTOMY OF THE STERNO-MASTOID.

The two heads are best divided from separate punctures just above the clavicle. The muscle being made prominent by one assistant manipulating the head and another depressing the shoulder, the surgeon, standing facing the patient on the side to be operated upon, defines the limits of the inner border of the sternal tendon, opens the fasciæ sufficiently freely here, and then, taking a blunt-pointed tenotome, insinuates it horizontally behind and close to the tendon till it is felt just beneath his left index finger, which is placed at the outer margin; the edge is then turned towards the tendon, and divides it. It is withdrawn with the usual precautions. The clavicular tendon is divided in a similar way through another puncture.

Care must be taken to avoid the anterior jugular, which runs outwards under the muscle a little above the clavicle, and the external jugular, which lies at a varying level close to the outer border of the clavicular head. If a sharp tenotome were dipped too deeply, the internal jugular might also be wounded.

If any smart venous hæmorrhage occur, a pad of dry gauze should be firmly bandaged on.

The **open method**, in which the muscle is divided on a director after a skin incision has been made transversely over its lower third, and its borders defined, is advised by some as allowing of every step being seen, avoiding abnormal vessels and securing not only complete division of the muscle, but also of any fascial bands. These I have very rarely met with. The scar is said to be slight if the wound is sutured and carefully dressed (Tubby, *Orthopædic Surgery*, p. 202).

Causes of Failure after Tenotomy.

1. Septic troubles. These usually arise from the use of dirty instruments which clean themselves at the patient's expense, or from making an open wound.
2. Incomplete division of the tendon.
3. Division of important structures—*e.g.*, the tibial arteries, the external popliteal nerve, the anterior or internal jugular veins.
4. Non-union of the tendon.
5. Mal-union of the tendon—*i.e.*, adhesions formed by it to adjacent structures. *e.g.*, its sheath or a bone. These must both be extremely rare.
6. Breaking off the point of the tenotome, usually against a bone.

CHAPTER X.

OPERATIONS ON NERVES.

NERVE SUTURE.—NERVE STRETCHING.

NERVE SUTURE.

THIS may be required as a **primary** or **secondary operation**. The latter is accompanied with much more difficulty, owing to the greater retraction of the nerve ends, their bulbous or filiform extremities, their being often buried in scar tissue or matted by it to neighbouring parts—*e.g.*, tendons and fasciæ; to which must be added other unfavourable points—*e.g.*, the atrophy and fatty change in the muscles and the stiffness of the joints.

Primary Suture.*—As the mode of uniting nerves will be fully described under the head of secondary nerve suture, the more difficult proceeding, it need not be repeated here. It only remains to emphasise the importance of always resorting to it, and not trusting to spontaneous cure. As an instance of what may be done in very severe cases I may mention the following case:†

A woman of suicidal tendency wounded herself above both wrists. On the right side the radial, ulnar, and anterior interosseous arteries were divided, the radial and median nerves completely, and the ulnar almost completely. Apparently all the tendons were severed also. On the left side, the radial and ulnar arteries were divided, the radial and ulnar nerves completely, and the median nerve almost cut through. The superficial tendons were quite, the deep partly, severed. The nerves and tendons were sutured. Three weeks later sensation was perfectly normal and active, and passive movement was begun.

Secondary Suture.—The operation on the median or ulnar will be considered, as these are so commonly injured. The following steps must be remembered: (1) Finding the nerve ends. (2) Freeing and refreshing them. (3) Passing the sutures, and bringing the ends into apposition. (4) Dressing the wound, and the after-treatment.

1. *Finding the Nerve Ends.*—With accurate anatomical knowledge this is easy. An Esmarch's bandage does not appear to be

* Much information on the subject of primary and secondary suture will be found in the section of Suture of Tendons (p. 27).

† *Lond. Med. Record*, 1881, p. 152; Kraussould, *Centr. f. Chir.*, 1880, No. 47.

necessary, as the incision is made parallel with the vessels, and the use of one leads to oozing afterwards.* If bandages are employed, the parts should be made absolutely evascular; careless application will only cause most annoying oozing. An incision, 2 to 3 inches long, being made over and parallel to the nerve ends, the deep fascia and any scar tissue are carefully divided and the ends found, the upper bulbous and the lower filamentous usually,† and not always in a line with each other. They are next freed from the adjacent parts.

2. *Resection of the Nerve Ends.*—This is best effected by *sharp* scissors, with one stroke, and without any bruising. If the nerve is held with forceps, these must hold the sheath only. In case of primary suture, jagged or frayed ends need only be pared sufficiently. In later cases there is much more difficulty. Supposing the upper bulbous end to be taken first, I think that before this is pared the nerve should be carefully stretched,‡ so that dissecting-forceps or any other means of holding the nerve may inflict any necessary damage on parts that will be cut away. It is not necessary to cut away the whole of a bulb; removing the greater part will expose healthy nerve fibres. Mr. Bowlby (*Inj. and Dis. of Nerves*, p. 165) advises that the section of the upper end should be carried through the uppermost part of the bulb, close to the normal trunk. Not only will numerous young fibres be found here, but, as he points out, the tougher tissue of the bulb affords an excellent hold for the sutures. With regard to the lower end, Mr. Bowlby thinks that all that is needed is “to cut away the extreme end, which, being matted with fibrous tissue and compressed by the surrounding scar, is very likely to contain no nerve tubules. It is seldom necessary to remove as much as $\frac{1}{4}$ inch, and, however unhealthy the section may look, no good is ever to be gained by a further sacrifice.”§

3. *Passing the Sutures and bringing the Nerve Ends in Apposition.*—The suture should be of properly prepared carbolised silk or chromic gut. There has been much dispute as to whether they should be passed through the substance of the nerve itself

* Mr. Bowlby (*loc. supra cit.*, and Hunt. Lect., *Lancet*, July 16, 1887), thinks that the parts should be rendered bloodless. If this course is adopted care must be taken to provide sufficient drainage, and the upper bandage must, if possible, be applied sufficiently far from the wound not to interfere with pressing down the parts when the nerve ends are approximated.

† If the distal end be very difficult to find owing to its filiform shape and its being embedded in scar tissue, the wound should be prolonged, the nerve found lower down, and traced up to the distal end.

‡ An Esmarch's bandage, if applied, will be found in the way now, interfering, as it usually must, with the stretching of the nerve.

§ As the whole length of the lower end is in the same condition of degeneration or regeneration throughout, manifestly no good can be done by cutting off successive sections in the hope that the cut surface may look more healthy than that which is seen in the first resection (Bowlby).

or only through the sheath. Experience has shown that the former practice is not only harmless to the nerve, but is the method most generally applicable. In a few cases, as in that of a large nerve, where there is but little separation, and where the damage is just inflicted, it may be sufficient to pass the sutures through the sheath only. But in the opposite class of case the sutures should be passed through the nerve itself, and at a sufficient distance from the ends—viz., at least $\frac{1}{4}$ inch—otherwise when they are tightened they will cut out. Where there is much separation, several sutures should be passed through part of the depth of the nerve, one suture thus taking off some of the tension from its fellows. Another method is to pass one suture completely through the nerve trunk at least $\frac{1}{4}$ inch from each cut end. When the sutures in the nerve itself have been tied, two or three more very fine ones may be placed in the sheath, where the nerve is large enough.*

In cases of much separation, before any sutures are passed, and again before they are tied, the parts should be as much relaxed as possible, and the upper end brought down by pressing down the soft parts. Stretching the nerve has been already advised (p. 1282).†

All hæmorrhage being scrupulously arrested, and drainage provided by horsehair or a fine tube according to the amount of the disturbance of the parts, &c., the usual dressings are applied, and the limb placed on a well-padded splint in a position which will best retain the nerve ends in apposition with the least discomfort to the patient.

Amount of Nerve Tissue which may be Successfully Removed.—From $\frac{1}{2}$ to $\frac{3}{4}$ inch is probably an average amount.

Causes of Failure.—1. Wide separation of ends. 2. Atrophy, bulbous enlargement and sclerosis of nerve ends, so marked as to require much trimming, and thus tending to wide separation. 3. Unnecessarily rough handling of the nerve ends. 4. Suppuration of the wound.

Aids in Difficult Cases.—1. Previous stretching of the ends. 2. Approximation of the ends by position of the limb. 3. Using several sutures, which distribute the tension evenly. 4. The use of "stitches of fixation" (p. 28). The remaining methods must be looked upon, as yet, as experimental only. 5. Autoplastic operation with nerve-flaps. M. Letiévant advises to make a slit through the nerve with a narrow bistoury about $\frac{1}{5}$ inch from the end; the knife being then carried upwards for 1 or $1\frac{1}{2}$ inch, it is made to cut to one side so as to make a flap. The same is then

* To prevent the adhesion of the recently united ends to neighbouring parts, short strands of catgut may be placed beneath them, but this is not essential.

† In cases where, in spite of all precautions, much tension is evidently left on the sutures, it might be well to make use of "stitches of fixation," as in tendon suture (p. 28).

done with the lower end, and the two flaps, being turned towards each other, are united by their raw surfaces (Figs. 15, 16, 18). 6. Gluck and Vanlair advise that the nerve ends, whether united or only placed as closely as possible in apposition, should be passed through and left in a decalcified bone-tube, so as to keep the uniting material and granulations in a straight line. 7. "Distance sutures," *i.e.*, the substitution of threads of silk and catgut may be tried (p. 31). 8. Scar tissue may be used as a bridge between the ends. Thus, Mr. Pick (*Lancet*, 1892, vol. i. p. 693) in a case of secondary suture of the median nerve more than two years after the injury, found lying beside the upper cut end some organising inflammatory material. Dissecting this from the side of the nerve, and leaving it still attached to the lower end of the upper piece, he turned it down, and sutured it to the lower end of the nerve. When the patient was last seen the function of the nerve was in process of restoration. 9. Implanting one nerve trunk upon another. Thus, where the ulnar is too widely destroyed to bring the ends together, the distal end, frayed out, has been stitched to the median, the sheath and superficial fibres of this having been first removed. The success seems to have been slight and partial. Dr. R. Harvey Reed, of Columbus, Ohio, publishes a case successfully treated after the following method, which he credits to Dr. W. I. Galbraith, of Omaha, Nebraska. This is intended to meet those cases where the gap between the central and peripheral ends is so great that it cannot be met by suture, or bridging across by catgut, or trunnelled over by a tube of decalcified bone. Dr. Galbraith has shown by a case that, under the above circumstances, if the injured nerve have another parallel with it, the central end of the injured one can be implanted into a parallel nerve at a certain point, and that 2 or 3 inches lower down the peripheral end can be implanted into the same nerve. The impressions of the injured nerve will be carried through the section of the parallel one, from the central end to the peripheral end of the injured nerve, and *vice versa*. 10. Perhaps the use of zigzag incisions made in the upper end (Fig. 17, p. 31). 11. Making use of nerve-grafts. Gluck has resected $1\frac{1}{2}$ inch of the great sciatic in chickens, and replaced it by a bit of a rabbit's sciatic sutured in. The birds walked afterwards as well as those treated by direct suture.

The following is, I believe, the first case of nerve-grafting in this country. Mr. Mayo Robson (*Clin. Soc. Trans.*, vol. xxii. p. 120) after the removal of a growth from the median nerve, leaving a gap of $2\frac{1}{2}$ inches between the ends, successfully made use of a corresponding bit of the posterior tibial nerve from a limb which was amputated in the adjoining theatre.* The following conditions are rightly given as essential: First, the entire absence

* In its brief transit the nerve was placed in a solution of carbolic acid (1 in 40).

of tension; $2\frac{1}{2}$ inches of nerve being employed to fill an interval of $2\frac{1}{4}$ inches. Secondly, great care was observed in handling the nerve to be transplanted. Thirdly, the transplanted posterior tibial nerve was transferred immediately as living tissue into its new bed. Fourthly, only one fine catgut suture was employed at each end to fix the nerve. The same surgeon successfully used the spinal cord of a rabbit as a graft in the median nerve of a man (*Brit. Med. Journ.*, Oct. 31, 1896, p. 1312).

In a very instructive paper by Mr. Damer Harrison, of Liverpool (*Clin. Soc. Trans.*, vol. xxv. p. 166), some nine other cases of nerve-grafting are given. The nerves used were the sciatic of recently killed rabbits or kittens, and the median from a human arm. Of the ten cases, three are stated to have been perfectly successful, six partially successful, and only one a failure.

Mr. Heath made use of nerve-grafting, replacing the gap in the ulnar by a portion of posterior tibial nerve (*Lancet*, 1893, vol. i. p. 1195). A fibro-sarcoma had been removed from the ulnar nerve on the inner side of the right arm, but it had been found impossible to bring the ends of the nerve together as a gap of 2 inches existed between them. Four days after the first operation the wound, which was healing well, was reopened, and enlarged at either end. The ends of the ulnar were found, and about $\frac{1}{8}$ inch cut off from each end. Then $2\frac{1}{2}$ inches of the posterior tibial nerve from a limb which had just been amputated by Mr. Beck for sarcoma of the lower end of the femur were grafted into the gap in the ulnar nerve. The graft was retained in position by two fine silk sutures at either end. About twenty minutes elapsed from the time at which the limb from which the nerve was taken was severed from the body and the time when the junction of the piece of nerve with the ulnar nerve was completed. The wound healed by first intention, but fourteen months later there was no restoration of function in the nerve.

Mr. M. Moullin, in a case of old injury to the musculo-spiral nerve, grafted in about 2 inches of the great sciatic of a rabbit, but without success.*

Period Required for Repair.—The following appears to be a fact not sufficiently recognised. The period required for union after secondary nerve suture is very much longer than is usually supposed to be necessary, owing to the peripheral end being degenerated, the muscles atrophied, and the joints fixed. Complete restoration of function will often require from one to two years. A patient who leaves his surgeon apparently but little better for the operation may return at the end of the above

* In cases of injury to the musculo-spiral nerve where the ends are too far apart to admit of their junction by suture, they have been successfully approximated by resecting sufficient of the humerus. Wheeler (*Lancet*, 1894, vol. i. p. 939), Mann (*ibid.*, 1893, vol. ii. p. 59).

time with his limb practically restored to its natural condition.*

It is the above condition of the muscles and joints which alone puts anything like a limit on the period at which secondary suture can be successfully practised.

The longer the interval† between the injury and the suture, the more perseveringly must friction, electricity, passive and active movement, and massage be made use of, and the more will patience be required by both patient and surgeon.

NERVE STRETCHING.

This operation, introduced into England in 1880, and much used in the immediately succeeding years, has fallen into abeyance, the clinical results having failed to come up to the expectations raised by the operation.

Indications.—Of the following list it is only in the first six that the operation can be considered justifiable.

1. Neuralgiæ.—In all cases where previous treatment has failed, nerve stretching may be practised before division of, or removal of, part of a nerve.‡ The conditions justifying this in facial neuralgia have been already given (p. 254). As, however, the results of neurectomy for facial neuralgia are far superior to those of nerve stretching, the latter is only to be recommended on the ground that, owing to the inveteracy of the disease, recurrence is only too probable even after neurectomy, and thus a previous nerve stretching may give a further period of relief. 2. Sciatica.—Nerve stretching is especially indicated here in cases due to rheumatic inflammation of the nerve from exposure to cold and wet.§ The more definite is the sensation of adhesions broken down at the time of the operation, the better is the prognosis. 3. Locomotor ataxy.—One or both great sciatics have been stretched with a view of improving the lightning pains, the involuntary jerking of the lower limbs, and the gait.|| While improvement for a varying period may always be expected as far as the first two are concerned, the prospect of improving the ataxy is very doubtful. Furthermore, the slow healing of the wound in these cases must be borne in mind. 4. Spasmodic contractions of voluntary muscles.—Here the operation seems to have been followed by success, temporary at least, in a very large number of cases. Where the

* Mr. Bowlby (*loc. supra cit.*) writes: "If there is one fact more than another which stands out in the clinical histories of patients who have been under my own observation, it is that after the failure of union by first intention, after trophic changes of many kinds, after complete atrophy and degeneration of the paralysed muscles, recovery may yet be complete."

† The longest of these with which I am acquainted is a case of M. Tillaux's in which fourteen years had elapsed between the injury to the median and its suture.

‡ See a paper by Mr. Walsham (*Brit. Med. Journ.*, December 1880), in which the possible causes of relief after nerve stretching for neuralgia are discussed.

§ Dr. J. P. Bramwell has published (*Brit. Med. Journ.*, June 19, 1880) five cases of this kind, in which much benefit followed stretching the great sciatic.

|| In a case of Dr. Bastian's (*Brit. Med. Journ.*, July 2, 1881), the patient, in an advanced stage of ataxy, experienced so much relief from the stretching of one great sciatic, that he asked for an operation on the other side. An interesting paper by Dr. Cavafy, with nineteen cases collected from different sources, will be found in the *Brit. Med. Journ.*, 1881, pp. 928, 973.

spasmodic affection is of traumatic origin—*e.g.*, where a limb, after a contusion, is at the same time contracted and the seat of spasmodic movements—stretching of the nerves concerned may be absolutely curative. Quite another class of case—*viz.*, stretching the facial for tic convulsif—has been considered at p. 265.

5. Reflex epilepsy.—Prof. Horsley (*Dict. of Surg.*, vol. ii. p. 61) states that, in those cases of epilepsy where the attack is preceded by violent pains localised distinctly to different nerves, very marked relief (amounting to cure in several instances) has been obtained by stretching the nerve trunks thus indicated.

6. Anæsthesia of leprosy.—Lawrie, of Lahore, seems to have met with striking success, the fifty cases published being all successful. The late Dr. B. Rake (*Brit. Med. Journ.*, 1890, vol. ii. p. 953) advised repeated stretching of the great sciatic as preferable to amputation for the painful perforating ulcer of leprosy.

7. Tetanus.—Owing to the fatality of traumatic tetanus, nerve stretching may be tried here if the case is seen at a very early stage of the disease. But owing to recent knowledge of the pathology of the disease, and our ignorance as to the date at which the spinal cord is affected, this treatment cannot be looked upon as hopeful.*

8. Infantile paralysis.—Prof. Horsley (*loc. supra cit.*) states that in 1861 Dr. Bastian had the great sciatic nerve stretched to improve the nutrition in a limb the seat of the above disease. The effect was to markedly increase the temperature and colour of the part, and apparently improve the state of the tissues. The result, however, does not seem to have been such as to find imitators.

Operation.—The following remarks refer to the great sciatic only, the nerve which has been most frequently stretched.

† The parts being cleansed, an incision about 4 inches long is made over the nerve in the centre of the back of the thigh, commencing about $1\frac{1}{2}$ inch below the lower border of the glutæus maximus. The interval between the hamstrings being hit off, retractors are inserted, and the nerve found a little to the inner side of the biceps. The fatty tissue around it is then carefully incised till the white epineurium itself of the nerve is exposed. The nerve, being most entirely separated from adjacent parts, is now stretched. The force with which this is accomplished must vary somewhat with different cases. Thus, in sciatica, the index finger ‡ being hooked under the nerve, this should be raised well out of its bed in the hope of adhesions being felt to give way both at the part stretched and at a distance also.

In the case of locomotor ataxy the same amount of stretching—*viz.*, hooking up the nerve some 2 inches above the level of the skin, and some 4 or 5 above its bed, this being repeated twice in a centrifugal and centripetal direction—has been followed by satisfactory results. In other cases the pull has been more forcible, care being taken to lift the limb off the table several times. In any case the pull must be without jerks, steady and continuous, and kept up for some three minutes.§ The direction of the pull, whether downwards from the trunk

* Mr. H. Morris points out (*Brit. Med. Journ.*, January 14, 1882) that in one case of acute tetanus claimed as a cure by nerve stretching, the medicinal treatment adopted (Calabar bean) was too active to permit of any conclusion in favour of the operation.

† Ether should be given in preference to chloroform, if possible. In some cases where anæsthetics seemed contra-indicated, the ether spray was made use of. Injections of cocaine might be tried.

‡ In the case of smaller nerves a blunt hook would be employed.

§ Mr. Marshall (*loc. supra cit.*) thought that a force equal to 30 lb. or 40 lb. should be the limit for the sciatic. He thus gave an idea of the above force: "If I first pull as hard as I imagine I should do upon a living sciatic nerve during an operation, I find that the force employed is about equal to 20 lb.; but

or upwards from the limb, has been a good deal disputed. Mr. Marshall (*Bradshawe Lecture*, p. 28) thought that in neuralgia the stretching should be performed both ways. In ataxy it is essential to stretch down from the body.

The nerve, being found to be loose and elongated, is replaced in its bed, any bleeding points are attended to, drainage provided, and the wound carefully closed. Antiseptic precautions must be made use of throughout, and the limb kept quiet with a splint or sand-bags. The tardy healing of the wound in cases of ataxy has been already alluded to.

In cases of stretching for sciatica, gentle movements of the limb should be begun as soon as possible to prevent the re-formation of adhesions.

if I pull very hard, it is increased to 30 lb., and that, I believe, is as hard as a surgeon could well pull when holding a soft nerve between his finger and thumb."

PART VI.

OPERATIONS ON THE VERTEBRAL COLUMN.

SPINA BIFIDA. — LAMINECTOMY. — RACHIO- TOMY. — PARTIAL RESECTION OF THE VERTEBRÆ. — TAPPING THE SPINAL THECA.

SPINA BIFIDA.

Indications.—The Clinical Society's Committee appointed on this affection reported as follows: (*Trans.*, vol. xviii.) "1. Notwithstanding many failures, the plan of treatment by injection is the best with which we are acquainted, and the only one which we feel justified in recommending. 2. A more careful selection of cases than hitherto has been made is necessary. 3. Marasmus, hydrocephalus, and inter-current disease contra-indicate the operation. 4. In cases in which the operation may nevertheless be legitimately performed, we should consider the following as unfavourable circumstances: (α) Distinct evidence of the cord being in the sac, as shown by umbilication or a longitudinal furrow;* (β) A very thin membranous or ulcerated sac; (γ) Previous rupture of the sac; (δ) The occurrence of a distinct impulse between the tumour and the anterior fontanelle, or a sac the contents of which are easily returned into the spinal canal; (ε) A very early age of the patient. 5. The best result is to be hoped for in children who have reached the age of two months, in whom there is no paralysis or hydrocephalus, and when the sac is covered by healthy skin."

Operations.—1. Injection with Morton's Fluid. 2. Simple Tapping and Drainage. 3. Excision.

All the above are liable to be followed by septic meningitis aided by the constant soaking away of cerebro-spinal fluid, especially where the coverings of the sac are thin and unhealthy.

1. **Injection with Morton's Fluid.**—Owing to the large number of successes† which have attended the use of this method, it is the only one which

* Other points which make it probable that nerve trunks or the cord, or both, are present in the sac, are paralysis of the sphincters or lower extremities, a large sessile tumour with a broad base, and the appearance of cord-like bands when the sac is thin enough to transmit light.

† The Clinical Society's Committee collected 71 cases treated by this method. Of these, 35 recovered, 27 died, 4 were relieved, and 5 unrelieved. In a letter to the Committee (dated May 11, 1885) Dr. Morton was able to refer to 50 cases

was recommended by the Committee of the Clinical Society. It is impossible to point out too strongly to my younger readers that it is only by a judicious selection of cases that any success can be expected.

The sac being cleansed, a syringe which will hold about 2 drachms of the iodo-glycerine solution is chosen, and a fine trocar. The calibre of this must not be too fine for the thick fluid which has to pass through it. The puncture into the swelling should be made well at one side, obliquely through healthy skin, and not through the membranous sac-wall, the objects being to avoid wounding the cord or nerves, and also to diminish the risk of leakage of the cerebro-spinal fluid. Unless the sac is very large it is probably better not to draw off much, if any, of the fluid from the sac on the first occasion. The position of the child during the injection has been a good deal dwelt upon, most recommending that it should be upon its back. The Clinical Society's Committee advise that the child should be upon its side. About a drachm is the quantity recommended. Every care must be taken to prevent any continued escape of the cerebro-spinal fluid, now and later, it being clearly understood that any such leakage, which is most difficult to prevent, will lead to septic meningitis and death. When the needle is withdrawn the puncture should be pressed around it, and immediately painted with collodion and iodoform, a dressing of dry gauze being also secured with collodion. I prefer to give a little chloroform to prevent any crying and straining at the time. The child should be kept as quiet as possible afterwards, on its side, and an assistant should make sure, for the first hour at least, that no leaking is going on. Shrinking of the cyst, continuing steadily, shows that all is well. If the injection fail altogether, or only cause partial obliteration of the sac, it should be repeated at intervals of a week or ten days.

2. **Simple Tapping and Drainage.**—This consists of either tapping with a very fine trocar and carefully sealing the opening, or inserting a single piece of horsehair as a drain. The use of the horsehair drain is not to be recommended, as the leakage cannot be kept sweet. The method is only palliative.

3. **Excision of the Sac.**†—This is the method which I recommend, and which, in spite of certain grave dangers, promotes, I think, the best results in carefully selected cases. The dangers are of course the suddenness with which the fluid may escape, with grave resulting changes in the hydrostatic pressure and circulation in the cerebro-spinal system, and shock from interference with important nerve filaments.‡

thus treated. Of these, 41 appear to have been successful, and 9 unsuccessful. But it is obvious that these statistics are largely unreliable. It is not unfair to say that nearly every successful case has been at once reported, while scores of unsuccessful ones have never been heard of.

* The fluid is iodine, gr. x; iodide of potassium, ʒj; glycerine, ʒj.

† The Clinical Society's Committee collected 23 cases treated by excision of the sac. Of these, 16 recovered, 7 died. They point out that no mention of the contents of the sac is made in 6 cases; that nerves were certainly absent in 16 cases; and that in 1, which was fatal, they were certainly present (*Trans.* vol. xviii. p. 380).

‡ It is greatly to be desired that in every case accurate details should be given as to the contents of the sac. Mr. Mayo Robson (*Annals of Surgery*, 1895, vol. ii. p. 82) writes, "I believe that, contrary to what is usually taught, a far greater number of cases of spina bifida coming under notice are instances of meningocele rather than of myelocele, and therefore more amenable to radical treatment." G. A. Wright, on the other hand, well-known as an authority on these matters, and as a very skilful operator, writes (*Diseases of Children*, with Dr. Ashby, p. 480): "Either ligature or excision is almost necessarily fatal when the case is one of meningo-myelocele; as as this is the most common form, the plan should rarely

The too rapid escape of fluid can be prevented in great measure by preliminary tapping and attention to the position of the patient. The presence of nerves in the sac is a graver matter, but with a larger experience surgeons will, I believe, find that the nerves and the closely contiguous sac can be safely returned within the canal, and, when replaced, covered over. On this point Mr. M. Robson (*loc. supra cit.*) writes: "Even when nerve cords are involved in the sac, an aseptic plastic operation can not only be safely performed, but will actually do less damage to these important structures than the injection of an irritant, which, if it does not lead to rapid death by shock or convulsions, or to a general irritation of the nerve centres rapidly tending to hydrocephalus, is followed by a shrinking and atrophy of the sac and its contents whether nerves or spinal cord."

Operation.—The parts having been cleansed and arrangements made for keeping the head low prior to and during the opening of the sac, elliptical incisions* are made through the skin on either side on and sufficiently far from the base to ensure if possible (α) sound skin and (β) sufficient skin to meet in the middle line after partial excision of the sac and removal of the fluid. The skin is then dissected back on each side with great care so as to avoid, if possible, punctures of the membranes, until the laminae are reached. The sac is now carefully opened, at first with a trocar so that the fluid is slowly withdrawn, and the effects on the cerebral centres noted. The opening is then enlarged, and the interior carefully examined. If no nerve structures are present, the redundant sac is then cut away with blunt-pointed scissors, and the edges brought together with a continuous suture of catgut or, better, kangaroo tendon. So far the operation has been simple and straightforward. We must now consider more difficult cases. Where the coverings are in great part thin and translucent, even when this condition extends to the margin of the swelling, if the coverings can be rendered aseptic they may be partly utilised to form the meningeal flaps, in such cases the adjoining skin can be undermined and made to slide over the new meninges. (Mayo Robson).

When on opening the sac nerve structures are seen within, that part of their course which lies in the sac must be gently detached with blunt-pointed instruments, until they can be gently pushed through the opening that communicates with the spinal canal. In more difficult cases, incisions must be made with blunt-pointed scissors between portions of nervous structures, in order to set them free, or they must be returned with a large part of the sac *en masse*. In cases where the presence of nerve structures difficult to detach is marked, the safest plan will be the last. Having opened and examined the sac, the surgeon cuts away any superfluous part that is safe, then detaches the remainder and returns it with the nerves which run in it, through the opening, into the canal.† It is greatly to be desired that surgeons should specify what nervous structures were present, and how they were dealt with. As a rule this has been most imperfectly done.

or never be adopted. Mr. Mayo Robson and others have had some successful cases, but the facts remain as above stated."

* A precaution of Mr. Robson's (*Clin. Soc. Trans.*, vol. xviii. p. 211) should be followed here. The skin and meningeal flaps should be so cut that their lines of union, when sutures are applied, are not opposite. Thus, the flaps should be cut of unequal width, so as to bring, *e.g.*, the wider skin flap on the left side, and the wider meningeal one on the right.

† In those cases where there is a distinct peduncle, this, if hollow, must first be opened to inspect its interior. If it contain no structures of importance it is secured by running it round with a kangaroo-tendon ligature, and the sac beyond cut away.

The nerve structures having been returned, the flaps of meninges and skin are sutured separately and not in one line (p. 1291). In some cases periosteal grafts from freshly killed animals have been introduced with varying success.* Considering the tender age and feeble powers of these patients—infants, as a rule—it is certainly not worth while to prolong an operation, anæsthetic, &c., for this purpose. The very lowest part of the meningeal and skin flaps may be left unsutured, but no drainage will be needed, and leakage is greatly to be deprecated. A few strips of iodoform gauze wrung out of carbolic acid lotion (1-20) having been placed, with green protective, on the wound, a sufficient thickness of salicylic wool is then applied, and with firm and even pressure. A shield of silver, vulcanite, or thin sheet-lead should be worn later until the parts have thoroughly consolidated.

Causes of Failure after the Radical Cure of Spina Bifida.—

1. Leakage and septic meningitis. 2. Convulsions and rapid death.† 3. Paraplegia. The setting in of this after injection may be temporary or permanent. 4. Hydrocephalus. This also may make its appearance after the injection with iodo-glycerine or excision as happened in a case of my own three days after the latter operation. The nerves here were few and small and easily detached with the adjacent sac into the canal. 5. After tapping or injection the swelling may progress unaltered.

**LAMINECTOMY.—RACHIOTOMY.—PARTIAL
RESECTION OF THE VERTEBRÆ.‡**

This rare operation, which has of late been revived, must be referred to here under the following indications: A. *Cases of injury, i.e., Fractures and Dislocation.* B. *Penetrating wound of the canal.* C. *Cases of inflammatory disease.—e.g., Pott's curvature.* D. *Cases of new growth.*

A. *Cases of Injury.*—Here the operation has been suggested by the analogous one performed on the skull, and the large amount of success which has followed it. But the analogy is, for several reasons, a deceptive one. Thus, owing to the small size of the cord, an injury which would only damage the brain slightly, almost inevitably destroys the structure of the cord throughout its thickness. Again, it must be remembered that a fragment of bone often inflicts injury upon

* Dr. R. T. Hayes of Rochester (N. Y.) introduced twenty grafts of periosteum from a freshly killed rabbit. Three months later the case was reported satisfactory, with a firm, hard, resistant covering. (*Med. Record*, June 16, 1883.)

† Mr. Clutton, who brought a successful case of Dr. Morton's treatment before the Clinical Society (*Trans.*, vol. xvi. p. 34), mentioned another in which this treatment was immediately followed by fatal convulsions. The same proved fatal in about ten hours in a case under my care. Mr. Bennett, during the above discussion, mentioned a case in which, owing to the child being indisposed at the time, he declined to operate. On its way home the child died of convulsions. He remarked that if he had used the injection, this would have been credited with the convulsions.

‡ Of these names the third is the only one which is correct and sufficient. It is, however, too long and cumbrous for general use in these days of hurry. Rachiotomy, which we owe to Mr. Davies-Colley, is very good as far as it goes, but insufficient. In this operation a good deal more is done to the vertebrae than merely cutting into them. Laminectomy, like appendicectomy, is objectionable from its hybrid derivation, but as, like the above term, it is explicit, convenient, and already in general use, it will be used here.

the cord instantaneously and in a moment, and that irremediable * damage may be done, though all deformity may be removed by raising and straightening the patient, and by the elasticity of the bones and the contraction of the muscles. Further, the cord may be most severely damaged, though its theca shows no sign of injury.

Again, when the surgeon trephines the skull, he not only hopes that the damage is slight and often of a removable nature, but he also believes that the only damage to the bones is that which lies close to his trephine and finger. But in the case of the spine we are faced by this dilemma: If the fracture has been from direct violence, and the spinous processes and laminae have been driven in, it is only too probable that when these are elevated the spinal cord, so limited in size, will be found too much damaged to profit by the operation. On the other hand, if the fracture has been caused by indirect violence, it is almost certain that the bodies of one or more vertebrae will have been crushed down, and a portion shot back into the canal.† In this case the fragment which has inflicted the injury, and which is keeping up the irritation, will be in front of the cord and out of reach, even if the cord were in a condition to be much benefited by its removal. A surgeon trephining the spine under these conditions would be like one who trephined the skull in order to remove depressed fragments of the vertex, when all the time a portion of the base of the skull was lying jammed into the under surface of the brain.

But it is not only in the damage, but in the violence of the fracture also that no analogy lies between the two cases. Fracture of the spine is usually due to indirect violence, as when the neck is broken by a fall on the head, or when the lower dorsal spine is fractured by a fall of a sack upon the shoulders. Even when the fracture is due to direct violence, it is of an entirely different nature to that for which the surgeon hopes to trephine successfully in the skull, and one far more likely to produce extensive and crushing damage—e.g., the fall of coal or earth, or a fall from a height upon a projecting body.

Finally, permanent compression of the cord, compression that can be removed, as can fragments of the skull, is a very rare event.‡ Even where permanent compression is present laminectomy will do very little. The surgeon may find it possible to restore the lumen of the vertebral canal, but the cord has been crushed as well as compressed. Mischief, usually hopeless mischief, has been done, for it has been proved by experiments and otherwise that a crushed cord is incapable of regeneration.

It remains to be shown that trephining the spine is not only likely to be void of any good results, but that it also involves serious risks and entails additional dangers of its own. Thus, the conversion of a simple into a compound fracture, the formation of a large, deep, and more or less ragged wound, the risk of subsequent suppuration with free access to the sheath of the cord, the opening up of inflamed cancellous tissue with its various channels and exposure of these to possible suppuration—all these have, I admit, been lessened by the use of antiseptic precautions. But the risk, though diminished, remains; the large amount of venous oozing tending to soak quickly through in this region can only be met by frequent dressing. And though it has been shown that in some of

* Hence accounting for the very grave fatality of fractures of the spine, a fact held by some to justify trephining. The above account is taken from my article on "Injuries of the Back," *Syst. of Surg.*, vol. i. p. 673.

† This is a very common condition, judging from museum specimens. It is well illustrated by Figs. 93 and 94 in my article to which I have alluded above.

‡ J. Hutchinson, *Lond. Hosp. Rep.*; Thorburn, *loc. infra cit.* It will be noticed that permanent compression is a very different thing from irreparable injury. The latter is present, only too frequently.

these cases the wound has healed quickly, and though no improvement has followed, the spinal column has not been fatally weakened by the removal of the laminae and spine, yet the weakening for a time must be considerable; and it must be remembered that by the removal of these structures the mobility of the fractured parts will be much increased, and when any attempt is made to vary the position of the patient in bed, there will be, for some time, a risk of disturbing the fragments and thus of inflicting further injury on the cord.

It will be seen from the above that my own opinion is averse to any surgical interference in cases of fractured spine, owing to the amount of damage to the cord being usually, from the first, irreparable. To quote other writers: Mr. Thorburn (*Surgery of the Spinal Cord*, 1889, p. 160; *Brit. Med. Journ.*, 1894, vol. i. p. 1348) comes to the same conclusion, but draws an important distinction between the cord and its nerves. This writer thus sums up the question of operative interference in fractures and dislocations of the spinal column (*loc. supra cit.*). In compound fractures, operate. In fractures of the spinous processes and laminae, with injury to the cord, we also operate. In simple fractures and dislocations of the bodies of the vertebrae, if there is a reasonable probability that the injury is due to hæmorrhage,* operation is advisable, but in all other cases of this nature we cannot hope to do good save where the injury is below the level of the first lumbar vertebrae. In such cases laminectomy is an eminently valuable surgical procedure." Mr. Thorburn advocates surgical interference here on the following grounds: (1) "We may here expect a regeneration of the nerve roots, the physiological evidence being strongly in favour of such regeneration, and not against it, as in the case of the cord. (2) The absence of spontaneous recovery in such cases in itself indicates the presence of a mechanical obstacle, such as permanent compression by bone, blood clot or cicatrix, otherwise we should expect the roots of the cauda equina to recover, as other peripheral nerves after severe injuries." Dr. J. W. White (*Ann. of Surg.*, July 1889) strongly advocates surgical interference in fractured spine, believing that fracture of the laminae and spinous processes, and therefore relievable pressure on the cord, will not be found so rare as has been usually believed. I fear the weight of pathological evidence is all the other way. For my own part I should only be inclined to interfere where the following conditions are present: A history of a direct injury; mobility and displacement, laterally or downwards, of the spinous process; great local tenderness; the usual symptoms of swelling, &c.; and paraplegia less marked than usual.

B. *Penetrating Wounds of the Spinal Cord*.—Mr. Thorburn (*loc. supra cit.*) shows that while the percentage of recovery is good as to life, complete recovery of function is uncommon, owing to the little power of recovery of function after a destructive lesion of the spinal cord in man, especially in adults. He would also regard as useless the operation of suture of the pia mater as proposed by Chipault, and points out that it may be harmful not only by necessitating manipulation of the injured cord, but also by confining effused blood and serum, and thus increasing the pressure upon those parts of the end which has escaped section. With the nerve roots, on the other hand, which are capable of repair, operation and suture would be quite justifiable.

* Mr. Thorburn thinks that the following would be the most advisable steps in these very rare cases: A laminectomy at the seat of injury, and an endeavour to arrest the hæmorrhage and to give exit to the blood; this procedure being combined in the first instance with paracentesis of the meninges in the lumbar region after Quincke's method (*vide infra*), and this failing, a secondary laminectomy at the lower part of the spine.

C. *Cases of Inflammatory Disease—e.g., Pott's Curvature.**—Interference here will be but very rarely called for. For, on the one hand, the pathology of these cases is much more hopeful than in fracture, the paralysis here being due, not to pressure of displaced vertebræ, or to irremediable damage of the cord—*e.g., myelitis, degeneration*—but to the results of a chronic, localized, external pachymeningitis, producing pressure by a mass of scar-like connective tissue. On the other hand, we have abundant evidence that paralysis, even when of long duration, has a marked tendency to recovery, if the treatment by absolute rest in the recumbent position is vigorously enforced, and if potassium iodide is pushed in large and frequent doses, after the American method.†

Mr. Thorburn (*loc. supra. cit.*) gives the following **indications** and **contra-indications** for operation. **Indications:** (1) "Assuming the prognosis to be thus favourable, we are never called upon to perform laminectomy save under certain special conditions. It will not be argued that the recovery after laminectomy is more complete than that produced by Nature, and experience shows that relapses also are only too common after operation. The indications which appear to me to point to the necessity for operations are then as follows: A steady increase in symptoms in spite of favourable conditions and treatment. The presence of symptoms which directly threaten life. Thus, in my second case the secondary chest troubles were very grave.‡ Intractable cystitis would fall into this category, but it is by no means common, and we can hardly agree with those who hold that the condition is in itself incapable of spontaneous recovery.

* Reference should be made, in addition to the writings quoted above, to the following: (1) In cases of injury, Macewen, (*Brit. Med. Journ.*, 1888, vol. ii. p. 308; Keetley, *ibid.*, p. 421; Duncan, *Edin. Med. Journ.*, 1889, p. 830; E. Hart, a case of M. Péan's, *Brit. Med. Journ.* 1889, vol. i. p. 672; H. W. Allingham, *ibid.* p. 838; Chipault, *Gaz. de Hôp.*; *Arch. Gen. de Méd.*, 1890; *Rev. de Chir.*, 1890, 1891, and 1892; these careful and elaborate papers are now embodied in Chipault's work on the Surgery of the Nervous System; Schede of Hamburg, *Ann. of Surg.*, 1892, vol. ii. p. 230; Wyeth, *ibid.* August, 1894; Biddell, *Med. and Surg. Reporter*, March 30, 1895; Lejare, *Gaz. des Hôp.*, June 2, 1894; Arnison, *ibid.*, May 1895. (2) In cases of Pott's curvatures, Macewen and Duncan (*loc. supra cit.*); Wright, *Lancet*, July 14, 1888; W. A. Lane, *Brit. Med. Journ.*, April 20, 1889; *Lancet*, July 5, 1890; Abbe, *New York Med. Journ.*, Nov. 24, 1888; Kraske, *Centr. f. Chir.*, 1890, Heft 25; Dr. S. Lloyd of New York, *Ann. of Surg.*, 1892, vol. ii. p. 289; Bullard and Burrell, *Trans. Med. Orthop. Assoc.*, vol. ii. p. 241. Several of the above cases have been reported so soon after the operation that their value would be much increased by the authors giving later details. (3) In cases of new growths, Dr. Gowers and Mr. Horsley's paper (*loc. supra cit.*) and the appended table. See also Dr. J. W. White's paper (*loc. supra cit.*), and his table of the most obvious diagnostic points, p. 32; and Starr, Tumour of the Spinal Cord, *Amer. Journ. Med. Soc.*, June, 1895, one of the most recent and important contributions to the diagnosis and treatment of this disease.

† In an adult gr. x-xx is given every half-hour, if possible, in a large glass of milk.

‡ Dr. Parkin of Hull, in a valuable paper (*Brit. Med. Journ.*, 1894, vol. ii. p. 700) illustrated by cases of laminectomy for spinal caries, mentions a case aged nine, admitted for cervical caries, cyanosis and bronchitis. As the condition became more critical, the sixth cervical spine was removed. The cord was found compressed and bent by a mass of bone and fibrous tissue, the remains of the fourth and fifth vertebræ. When the cord was freed, pulsation returned. Very great benefit followed on the operation, but the child died nearly three months after of tubercular meningitis, thought to be due to a caseating gland found at the autopsy. No evidence of caseation or recent caries was found present in the vertebræ.

"The persistence of symptoms in spite of complete rest,* is the indication which has been most commonly adopted, but, as we have already seen, such symptoms may persist for very long periods and then yield to absolute rest. It is, however, not improbable that, in a few cases, cicatricial pachymeningitis, or rather peri-pachymeningitis, may remain after the original pressure-lesion has ceased to act, and may thus keep up paraplegia until the constricting tissue is removed.

"4. In posterior caries (that is, in caries of the arches of the vertebræ) operation is clearly indicated, as here we can readily both treat the paraplegia and remove the whole of the tuberculous tissue. Two cases of this nature are recorded by Abbe and by Chipault respectively, and both proved highly successful.

"5. In my fifth case, the existence of severe pain, which was rapidly exhausting the patient, was regarded as an indication for surgical interference.

"6. Lastly, children as a rule yield better results than do adults, so that, other things being equal, childhood may also be regarded as an indication for operation.

"**Contra-indications.**—The presence of active tuberculous changes in other organs. Macewen holds that we should not operate when there is pyrexia, which is almost tantamount to saying that we should not operate in presence of active tuberculosis. If, however, the pyrexia were clearly due to cystitis, then we might regard it as an indication for, rather than against, interference. Again, general meningitis (although fortunately very rare) will at times obviously be present and will probably prove fatal whether we operate or not."

C. *Cases of New Growth.*—Mr. Horsley has here, as in so many other instances connected with the surgery of the central nervous system, operated with brilliant success (*Med. Chir. Soc.*, vol. lxxi. p. 383). The patient was one of Dr. Gowers', aged forty-two, and his chief symptoms were complete paralysis of the lower limbs and abdomen, the former being frequently flexed in clonic spasms, the pain accompanying these being extremely severe. There was loss of tactile sensibility as high as and involving the distribution of the fifth dorsal nerve. The bladder and rectum were completely paralysed. The growth proved to be an almond-shaped fibro-myxoma resting on the left lateral column, in which it had formed a deep bed, and adherent to the fourth dorsal nerve.† The patient recovered perfectly, the report being continued up to a year after the operation.

Operation.—The patient being placed as far as is safe in the prone position, and the skin rendered scrupulously clean, an incision is made down to the spinous processes, with its centre opposite the point of the angle of curvature, the site of the supposed displacement or disease. The deep fascia‡ and the tendinous attachment of the muscles are then cut from the spines, and the muscles completely detached from these processes, the laminae, and from the transverse processes as far as is necessary, by the edge of a short, stout scalpel. To prevent

* Readers with careful and well-balanced minds will not fail to note on reading the accounts of many of these cases, published as successful cases of laminectomy for spinal caries, that many of them before being submitted to operation, had only been treated by rest for a few days or weeks, "the mother having full directions to keep the child in the same horizontal posture." In other cases, after a brief period of in-patient treatment, the children have been sent out in Sayre's jackets to attend as out-patients.

† Much difficulty was met with, even in Mr. Horsley's hands, in localising the growth. Six and parts of a seventh laminae were removed; and it was found that the growth was situated 4 inches above the level of complete anaesthesia. An elaborate list of intra- and extra-dural growths of the spinal cord will be found in the appendix to this article.

‡ Mr. Horsley finds it needful to divide the deep fascia, not only along the spinous processes, but also at right angles opposite the middle of the incision in order to prevent its resisting proper separation of the sides of the wound.

hæmorrhage, Spencer Wells' forceps are quickly applied, and then sponges are tightly packed into the incision on one side of the spine, while the operation is proceeded with on the other. Efficient compression will usually suffice. Any vessels that require it being tied, and the muscles held back with retractors, the periosteum is reflected with a suitably curved elevator. Two or three spinous processes, if unfractured, are then cut off close to their bases with powerful bone-forceps with jaws at different angles. The laminae may be next removed by spinal saws, aided by a trephine, but the most speedy method is by using Mr. Horsley's bone-forceps devised for working at the bottom of a deep, steep wound-cavity.* A chisel and mallet may be used along an already made saw line, to complete the section; but even here the vibrations may be hurtful. Where the arches and the dura may be adherent, the bone must be removed with great caution; "picked away piecemeal," Tubby (*Orthop. Surg.*, p. 74). In the case of fracture, any loose bone will of course be tested and removed by sequester-forceps. The ligamenta subflava are next cut through with a sharp knife. The dura mater, covered with peculiar vascular fat, is next exposed. To avoid troublesome hæmorrhage from the numerous veins of this tissue, it must be opened strictly in the middle line and then kept with broad retractors pressed against the sides of the spinal canal, while the dura mater is opened (Horsley). This being done with knife and dissecting-forceps in the middle line, the cerebro-spinal fluid escapes freely, and should be mopped out with sponges as long as it flows. If the patient is kept quiet, and the spine horizontal, and the head not raised, this flow will soon cease (Horsley). Any growth is then removed, and the cord inspected and palpated very freely, so as to reveal any change in its density. If it be suspected that a fragment of bone or a new growth be pressing against the front of the cord from one of the vertebræ, Mr. Horsley advises that the sides and anterior aspect of the cord be explored by the careful passage of an aneurism-needle. Where the dura mater has been opened for exploratory purposes only, it should be sutured with fine catgut, one end being left open. If any growth has been removed from within, it will probably be wiser to provide for drainage of the sub-dural space with horsehair. The extra-dural space should be drained with a small tube.

In cases of caries, dense scar tissue, granulation tissue, pus, or a tubercular mass may present themselves when the dura mater is exposed. In some it will be sufficient to take away the diseased material, till pulsation of the cord reappears; in others the tougher leathery substance must be snipped away with scissors till the cord is exposed with a surface made as smooth as possible, and it is clear that, if not pulsating, it is not constricted. Any carious bone that is within reach will of course be removed by the sharp spoon. If, as is not unlikely, the mischief—*e.g.*, tubercular caries, abscess caries and granulation tissue—lie in front, this must be got at, if possible, by drawing the cord from side to side with an aneurism-needle, cautious removal of part of the transverse processes and adjacent bones. When all diseased bone, granulation tissue, &c., has been removed with the sharp spoon, a small flushing gouge (Fig. 326), or gauze mops, iodoform emulsion may be applied and strips of iodoform gauze wrung out of this left inserted for 36 hours. The dura mater is only to be opened when the state of the cord itself must be investigated, when sufficient mischief is not found outside, or when an intra-dural growth exists. This step is especially to be avoided in tubercular cases, as it may cause a tubercular meningitis (Chipault).

* The surgeon should take the trouble to be provided with the necessary instruments. The ordinary saws and forceps are quite unfitted for removing the laminae, and, in the case of the cervical spine, may, by prolonging the operation and pressing on the cord, bring about a fatal result.

Causes of Failure and Death after Laminectomy, &c.—I have only space to allude to these very briefly: (1) Shock. As I have already stated, the failure of the surgeon to supply himself with proper instruments may lead to needless prolongation of the operation and pressure on the theca which, especially in operations on the cervical region, may help to bring about a fatal result. (2) Hæmorrhage. This seems to have been rarely troublesome; the extra-dural plexus appears to be usually obliterated in cases of Pott's curvature. According to Chipault hæmorrhage has no special interest in the lumbar and dorsal regions, in the neck it is much more serious, since death has resulted three times from a lesion of the vertebral artery. (3) Respiratory trouble, probably largely due to the prolonged anæsthetic.* (4) Septic complications. (5) Tubercular or other secondary deposits elsewhere. (6) Temporary improvement followed by a relapse.

TAPPING THE SPINAL THECA.

This step was advised by Quinke as a means of relieving pressure symptoms in acute and chronic hydrocephalus, and also to aid in the diagnosis between serous, purulent and tubercular† meningitis. The interval between the third and fourth lumbar spines is taken, and the theca is found at a depth of four centimetres. The method deserves a further trial in cases of hydrocephalus as it is stated to be safer than tapping the ventricles.

* In one case (Deaver, *Inter. Journ. Med. Sci.*, Dec. 1888) the respiration became much embarrassed towards the end of the operation; this continuing till the patient's death three days later, was attributed to injury to the phrenic nerve with an exploring needle. The dura mater, thickened and adherent to the base, had been thus explored after removal of the third and fourth cervical arches, which were carious.

† Fürbringer found tubercle bacilli in twenty-seven out of thirty-seven cases of tubercular meningitis, one of which is stated to have ended in recovery (*Berlin. Klin. Woch.*, Nov. 13, 1893).

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